# Nanotechnology:
## balancing the promises

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# Nanotechnology: balancing the promises

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**ICN**
Catalan Institute of Nanotechnology
www.icn.cat

**Nanoaracat**
www.nanoaracat.com

**CNBSS**
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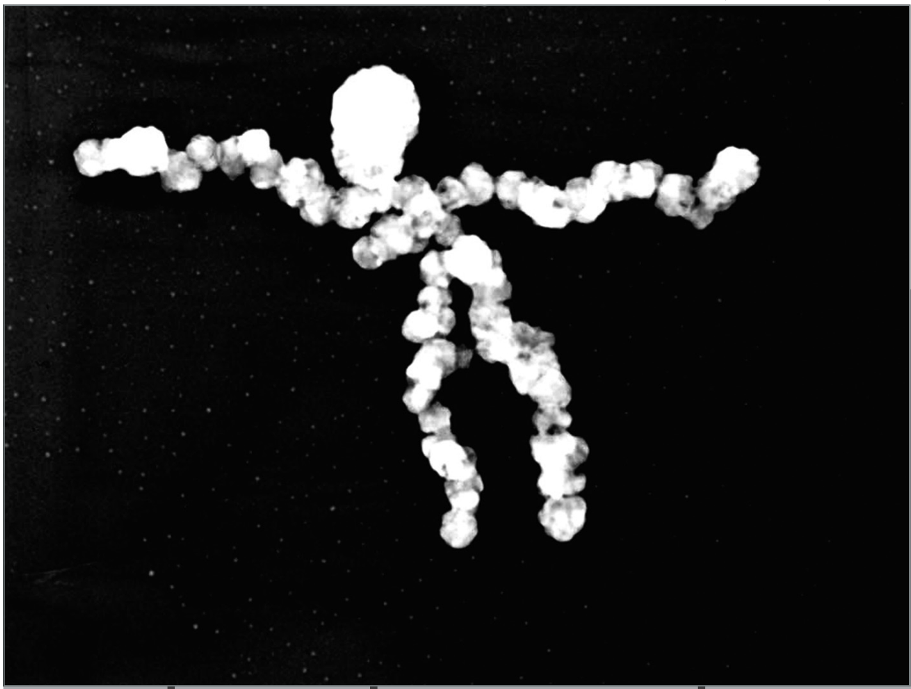
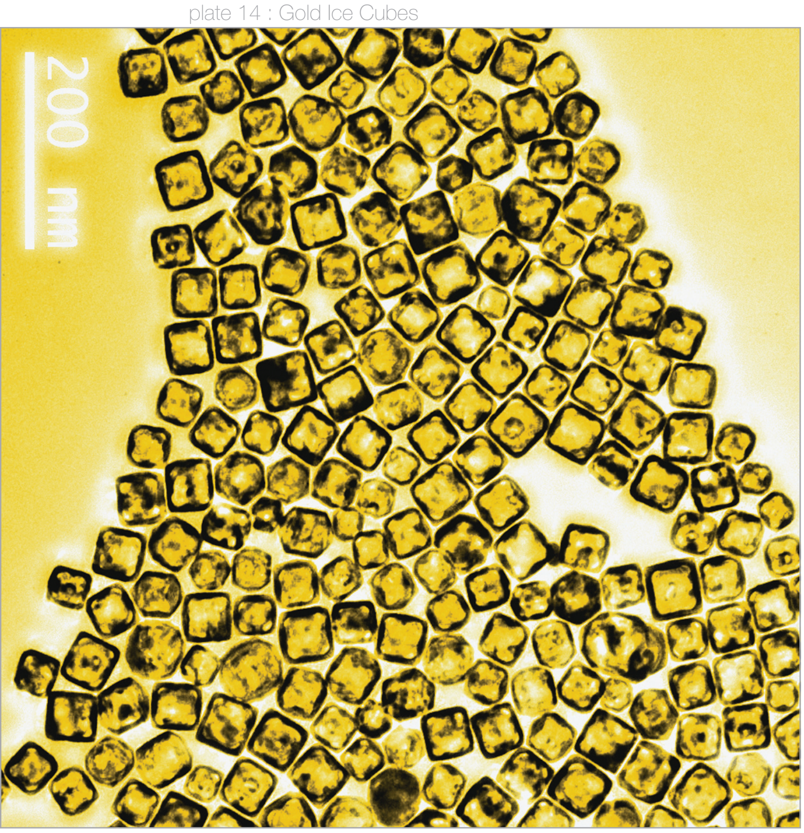


# balancing the promises

# Nanotoxicity, Nanomedicine and Public Opinion. Nanowiki 2009

We would like to start the year with some thoughts on some of the recent news appeared in Nanowiki 2009. In this occasion we would like to focus on probably one of the major impact areas of nanotechnology nowadays, that is, to solve the question of its preasumed potential uses in medicine versus its unknown potential in human health and environment risks. This new thing, does it heal or does it kill? Ultimately, both, the toxicity and the medical applications will emerge from the interaction dynamics between inorganic and organic matter at the nanometric (molecular) scale. The responsible implementation of Nanotechnology will result as a balance between the risks and benefits to society analyzed by a broad spectrum of stakeholders. Our intention is to promote the debate on the evolution of this young discipline, nanotechnology, for its safe and responsible development. In parallel, we would like to approach Nature to society through Science and Nanotechnology.

plate 14 : Gold Ice Cubes




To ease the reading of the text, bibliographic details have been removed and a list of scientists and institutions responsible for the commented news is provided at the end of the text.

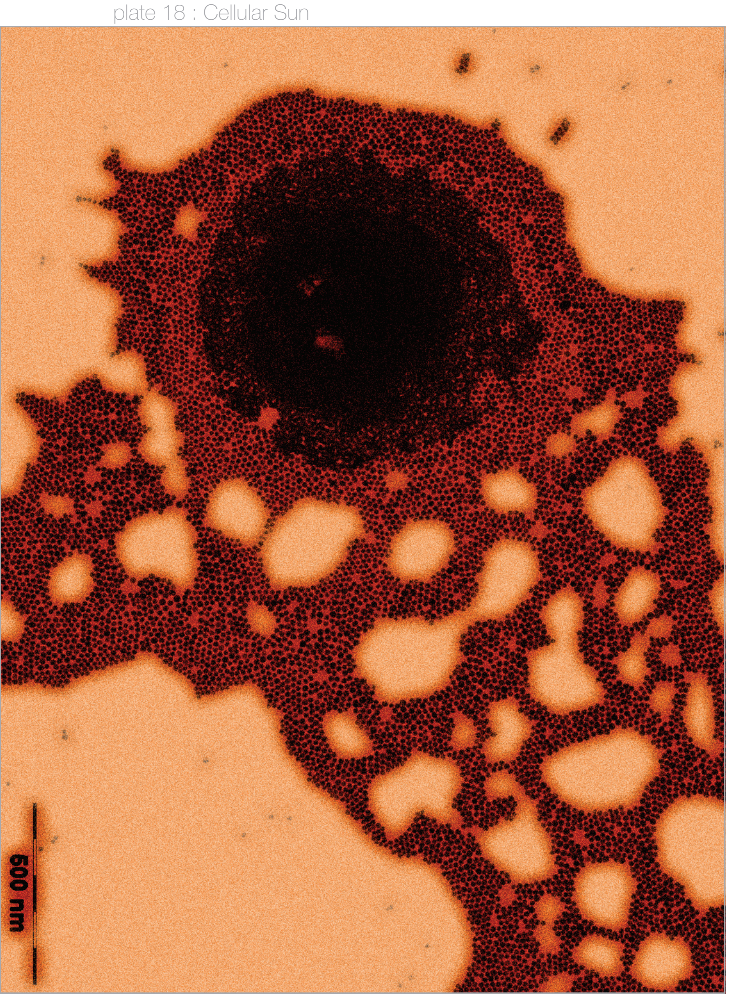
The text is accompanied by a series of electron microscopy images which summarize our efforts in the laboratory to explore the world at the nanoscale and the interaction between nanoparticles and biological systems, basically synthesizing building blocks, metallic and oxide nanoparticles, alloys and hollow structures and to study their coating, unspecific or specially design to mimic biological structures or to modify the biodistribution of anticancer drugs. The images have been selected from the pool of the images of our research by Anna Rierola, art curator in *Transcultural*.

# In front of the new

When facing what is new, mankind rise hopes and fears, and that is what is happening today with nanotechnology. The underlaying question is how will be the interaction between inorganic and organic matter at the nanometer scale and how it can interfere with biology and if this interaction can be used to monitor and repair biological states or if it will lead to uncontrolled intoxication of individuals and the environment. Regarding toxicity, it is useful to remember the Dosis sola facit venenum (only the dose make the poison) principle and the relationship between risk, hazard and exposure. Thus, electricity is extremely dangerous but it is perfectly canalized, similar with many chemicals and with a scalpel, which can be dangerous in the hands of the maniac and save lives in the trained hands of the surgeon. The mace or the leverage. Finally, it will depend on our intentions, and to master that, we need to properly know how it works.

To understand the framework of study, from very far, the planet earth re`presents a nanoparticle conjugate composed of an inorganic core coated by a thin layer of organic matter. Therefore, as life has evolved onto an inorganic substrate, the inorganic-organic matter interaction should not be especially troubling. However, although humans have been exposed to nanoparticles of natural origin during its evolutionary stages, from marine aerosols to volcanoes or forest fires, or even man-made nanoparticles, starting with ancient cosmetics or pigments (as the TiO2 nanoparticles found in the alveoli of more than 5000 years old Oetzi mummy), such exposure has already significantly increased over the last century due to anthropogenic sources such as internal combustion engines, power plants, and many other sources of thermodegradation of organic and hydrocarbon matter, which produce, among other, fullerenes (C60) and carbon nanotubes (CNTs). This exposure may still dramatically grow in the following years when nanotechnology based products are common. It is also worth noting that biogenic nanoparticles occur naturally in many species ranging from bacteria to protozoa to animals, as in the case of magnetosomes from magnetotactic bacteria, or ferritin, an iron storage protein of approximately 12 nm in size containing 5 to 7 nm hydrous ferric oxide nanoparticles core, also found in humans.

plate 18 : Cellular Sun



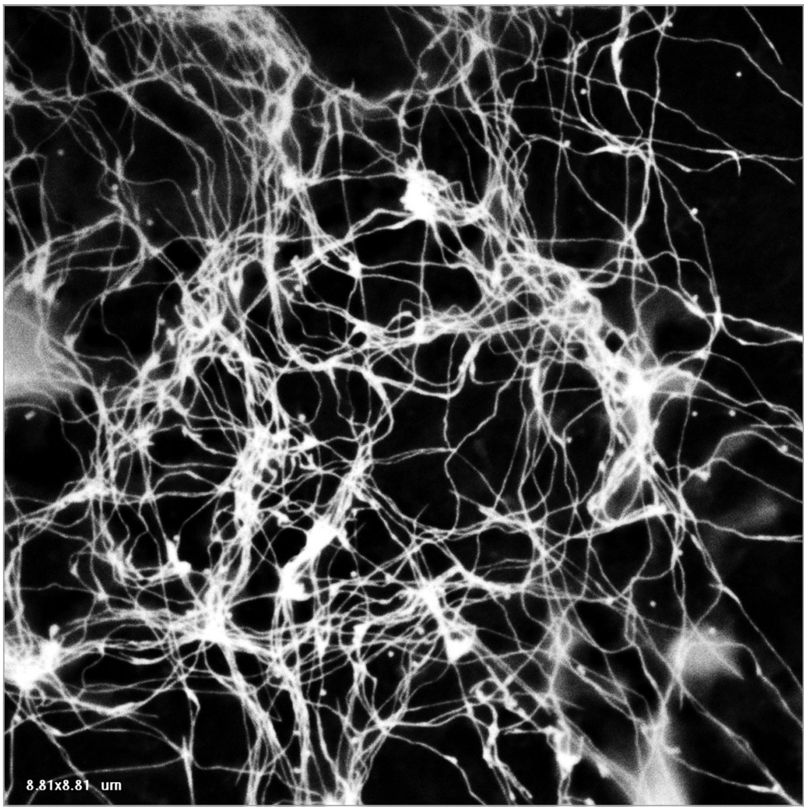
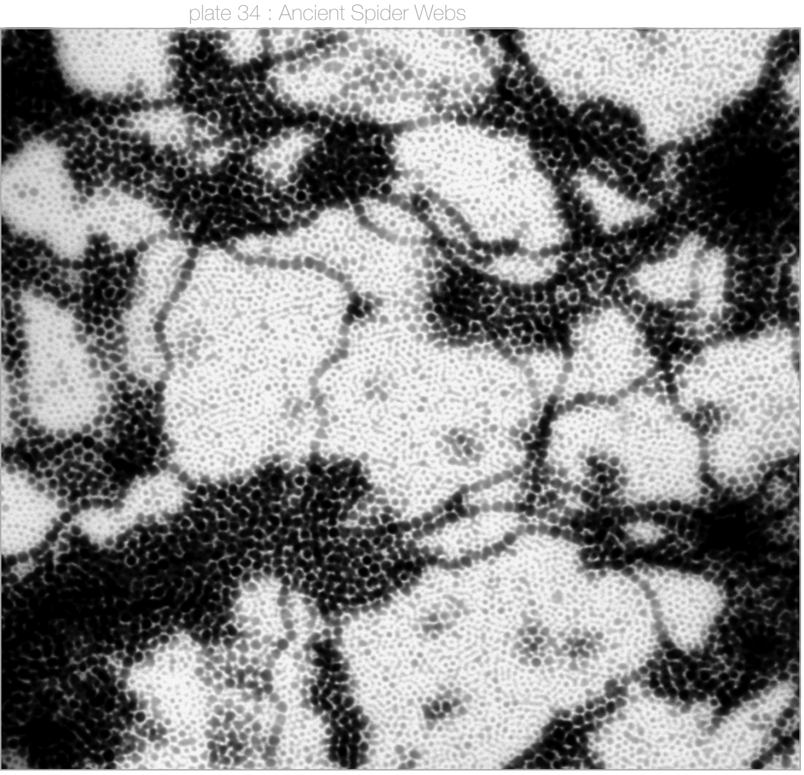




plate 19 : Silver Web

# Does the nanoform of a substance entails and increased danger?

To understand the evolution of nanotoxicology it is important to understand its historical context. In fact, it is known that foreign bodies, not only bacteria, viruses and parasites but also minute inorganic matter, can cause various pathologies, such as silicosis, asbestosis or inflammatory reactions. Toxicologists observed decades ago around the globe (starting with London and its smog) a close relationship between contamination and cardiovascular disease: emergency admissions due to Chronic Obstructive Lung Disease increase proportionally to the mass concentration of PM 2,5 (2.5 microns Particulate Matter) and PM 10 (10 microns Particulate Matter) in air, with a delay of few hours between the rise of contamination and the rise of admissions. However, the mechanism of how the presence of the particles in the lung affects the heart is still unknown. With the arrival of nanotechnology it was rapidly and conveniently thought that the solution to the mystery could be the presence of powerful tiny (submicronic) particles that had been repeatedly undetected, so small that they could easily translocate from the lung to the blood stream and then to the heart. This, together with the pulmonary fibrosis produced by the presence of asbestos fibers (again micrometric) in the mesothelium, and the consequent increased occurrence of lung cancer, has focused the attention of toxicologists on the effect of breathing in engineered nanoparticles. Thus, there have been efforts in

plate 34 : Ancient Spider Webs



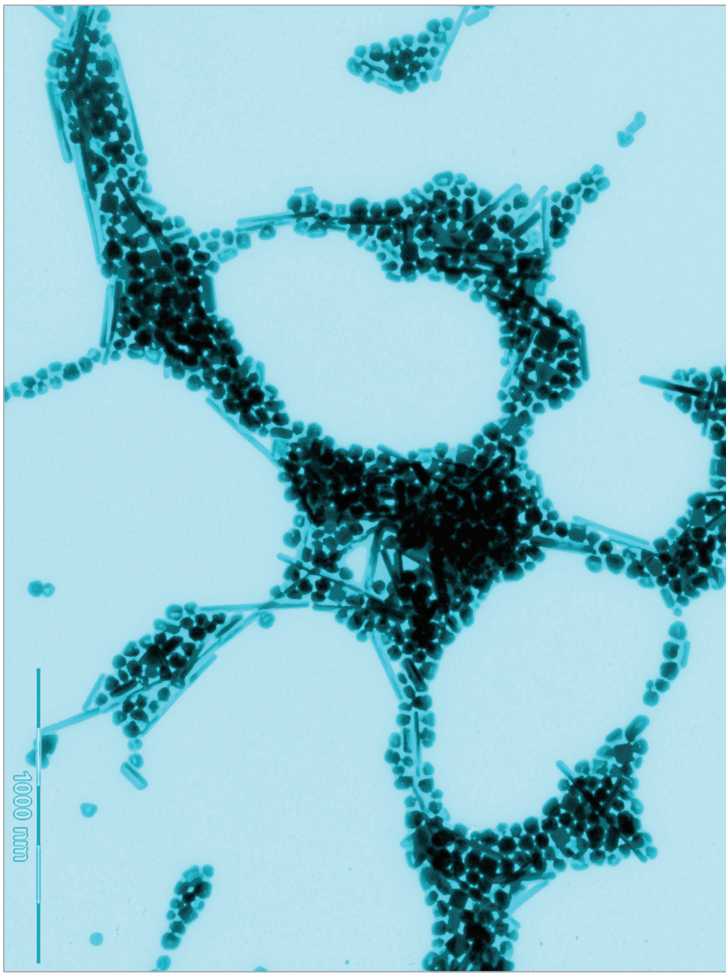



plate 21 : Birds in love

**Linking nanoparticle exposure to pulmonary fibrosis and mortality**, as reported in the study of the Occupational Disease and Clinical Toxicology Department at Chaoyang Hospital in Beijing involving seven healthy young women employed in a print plant. Over the course of a few months, all of the women were hospitalized for respiratory problems, accompanied by itchy eruptions of the skin on the face and arms. On examination, the patients were found to have liquid effusion around the heart and lungs, which proved resistant to all treatments. Comprehensive investigation led to a diagnosis, in all cases, of pulmonary fibrosis with consequent impairment of lung function. In front of the facts, the responsible of the work called for precaution. Given the increasing enthusiasm for nanotechnologies, the authors urged that priority should be given to protecting the public and the workforce. “We call on scientists throughout the world to work together and address this new challenge”, they

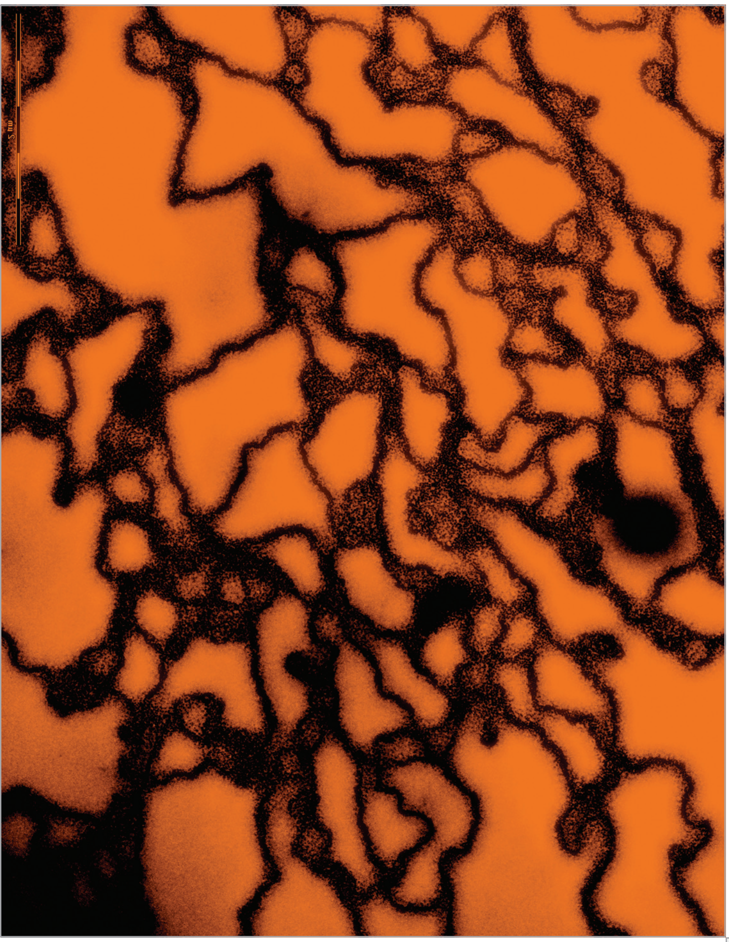


plate 29 : Smoke gets… 1

concluded. However, there are a number of issues with the evidence presented in the paper, which are causing leading nanotoxicologists to question the causal link implicated between the nanoparticle exposures and the consequent illness. In this situation, opportunely, SAFENANO, the UK’s premier independent resource on Nanotechnology Hazard and Risk, has prepared a special feature on this paper, which provides an impartial breakdown and appraisal of the study’s findings in order to assist readers in forming their own opinion on its importance and implications. It would also be appropriate to remember that cationic microparticles as pharmacological formulations or pigments have been repeatedly found toxic, in principle for the perturbance that positive charged nano and micrometric particles may produce in the negatively charged cell membrane. As an example, the polycationic paint components of the Acramin F system have led to severe pulmonary disease in textile printing sprayers in Spain and Algeria (Ardystil syndrome). In order to elucidate the underlying mechanisms of the toxicity of these nitrogen-containing polymeric polycationic paint components, it was shown that the cytotoxitity of the three polycationic paint components was markedly decreased in the presence of polyanions. It is concluded that the paint components execute part of their cytotoxicity by the abundant positive charges these molecules carry at physiological pH.

Risk Governance. In this context of confusion and reasonable potential risk if implementation is not developed responsibly, it is surprising realizing that the burden of collecting information about the toxicity of nanoparticles, which is important in determining how the use of nanoparticles will be regulated, is placed on regulatory agencies without the budgetary means to carry out this mandate. **And now what? Being responsible may be too expensive?** Probably the meaningful question is not how expensive it is to assess risk and who is going to pay for it. Being responsible is mandatory, and it could be enough to slow down commercialization until research on the potential negative impacts of nanoparticles has advanced and matured. In the meanwhile, we have to maintain the vision of a more efficient use of resources and understanding of nature at the electromagnetism length scale while exploring consequences.

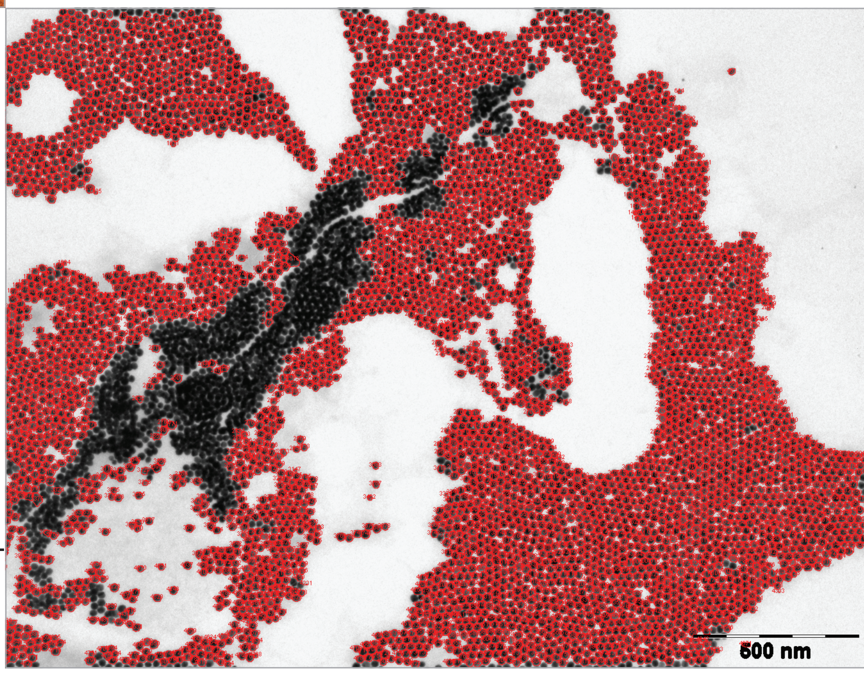



plate 12 : Distant Geography

Applications performed by specialists in controlled environments as in hospitals by doctors can be early implemented while non-regulated uncontrolled distribution in consumer goods could patiently wait until risk is properly assessed and tamed.

# Nanoremediation at large

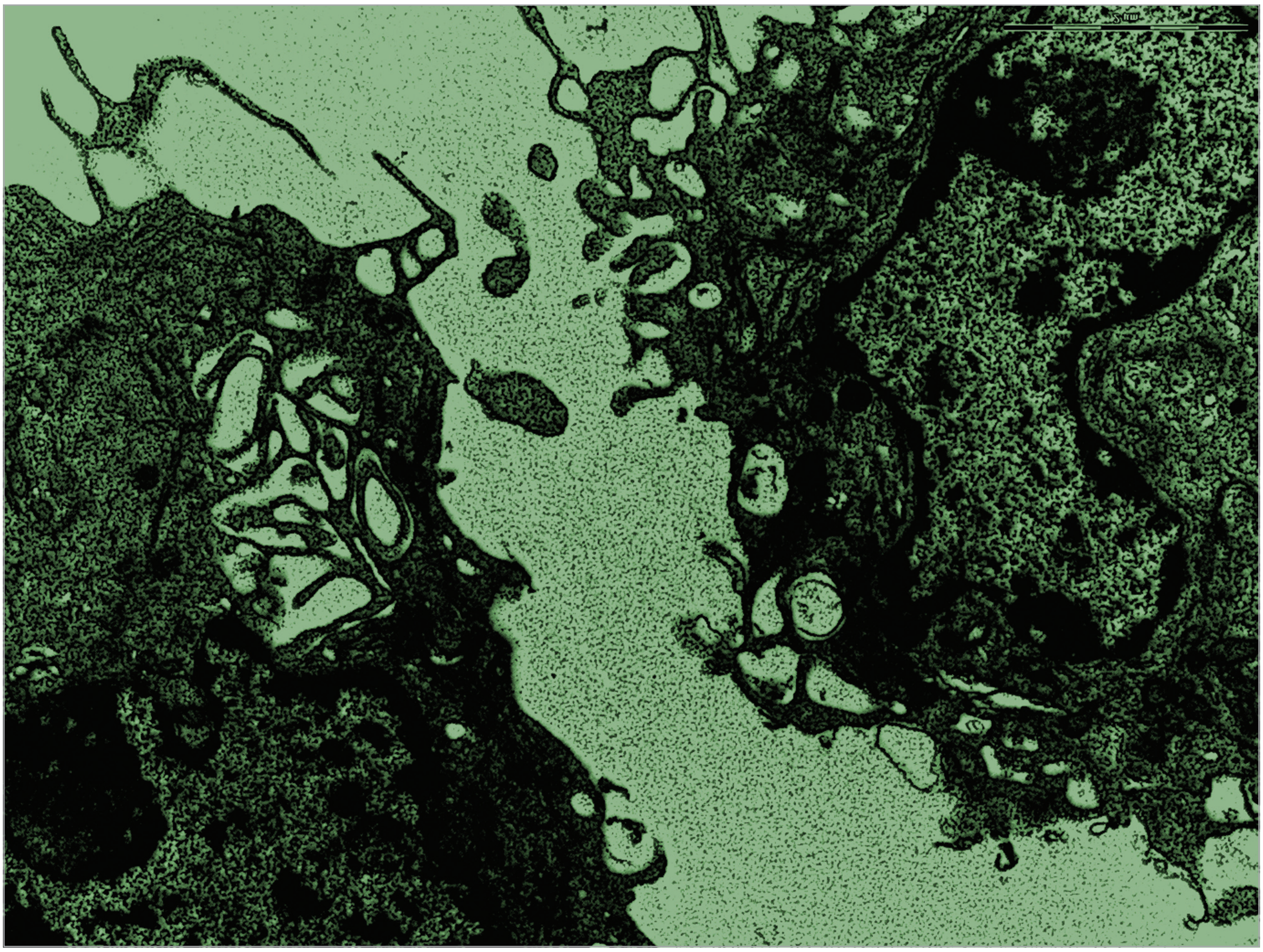


plate 26 : The Macrophages Desfiladero

A good example of equilibrium between benefits and risks is the increased interest of using nanoparticles for environmental remediation, what the voluntary distribution of nanoparticles in the environment would entail? Their tiny size and large surface area and some of their intrinsic nanoscale properties may make nanoparticles very efficient toxin-scavengers in water and soil. However, we have to test first if in some context these nanoparticles may be harmful for microorganisms and other forms of life and which is the Full Life Cycle of the different nanoparticles . That would be just makes things worse. And in the case it is so, to control if we can attack and degrade the toxins with low intensity attacks without harming life forms, which are supposed to have some defense mechanisms, which is not the case of persistent organic molecules or heavy metal ions. Nanoremediation has the potential not only to reduce the overall costs of cleaning up large scale contaminated sites, but it also can reduce cleanup time, eliminate the need for treatment and disposal of contaminated soil, reduce some contaminant concentrations to near zero—all in situ. The Project on Emerging Nanotechnologies has produced a map - Nanoremediation map - showing the location of sites at which nanotechnology has been used as a remediation technology and providing some information about each site. Authors of the work have searched the Web of Science for research studies and accessed recent U.S. Environmental Protection Agency and other publicly available reports that addressed the applications and implications associated with nanoremediation techniques. The report appears in **Contamined site nanoremediation**.

# Dealing with risks

As mentioned before, as electricity and many chemical substances, cars and scalpels, as ancient bonfires, the most likely scenario is that we will learn how to deal safely with it. In this direction, it was recently published a **GoodNanoGuide shares best practices: how to handle nanomaterials safely**, which is in principle directed to the first circle of people in contact with nanoparticles, those working in the nanotechnology research labs. The Rice University-based International Council on Nanotechnology (ICON) introduced the GoodNanoGuide, an online, community-driven wiki for information about the safe handling of nanomaterials. The beta version of the GoodNanoGuide can be found at their web site. Fostered by ICON, the GoodNanoGuide is a highly collaborative, interactive resource by and for the occupational safety and nanotechnology communities, law and industry. The GoodNanoGuide is a practical tool for people who handle nanomaterials as well as an online repository of safety protocols. It has been developed by experts from the worlds of nanotechnology, occupational safety and business and is governed by an implementation committee from North America and Europe. All GoodNanoGuide content is freely available via the Internet. Visitors may add their comments by becoming "Community Members," and experts may contribute and edit protocols by becoming "Expert Providers." A similar and related initiative is the Nanotechnology

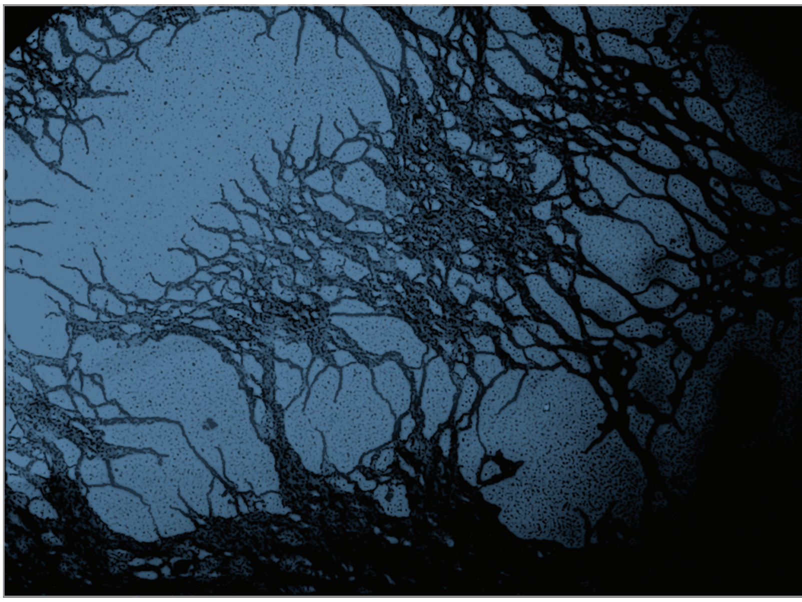
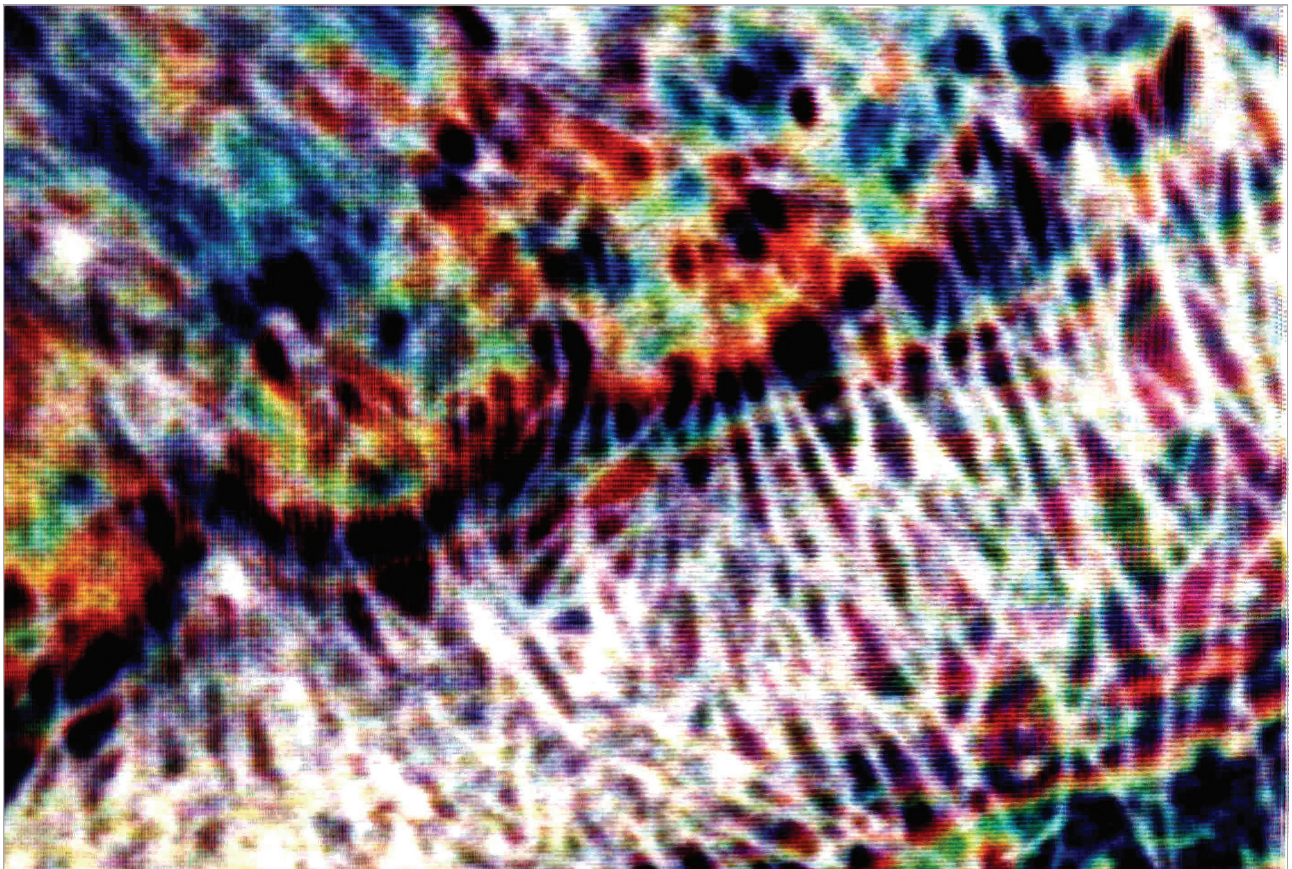


plate 24 : Deep in the Ancient Forest

Characterization Laboratory (NCL) – The Nanotechnology Characterization Laboratory (NCL) performs and standardizes the pre-clinical characterization of nanomaterials intended for cancer therapeutics and diagnostics developed by researchers from academia, government, and industry. This is part of the National Cancer Institute (NCI) of the National Institutes of Health. NCI is engaged in efforts to harness the power of nanotechnology to radically change the way we diagnose, treat and prevent cancer. The NCI Alliance for Nanotechnology in Cancer is a comprehensive, systematized initiative encompassing public and private sectors, designed to accelerate the application of the best capabilities of nanotechnology to cancer.

plate 22 : Stickiness and Interferences



# Nanomedicine. Sensing at the nanoscale

The best evidence of the potential toxicity of nanoparticles and nanomaterials is their promising uses in medicine. If nanoparticles interact with biological systems, in principle, this interaction can be just as beneficial as deleterious, depending on the situation. Thus, studies on nanotoxicology and nanomedicine should provide us the right framework to design the appropriate roadmap for responsible regulation and implementation. Regarding nanomedicine, the first application is related to the high susceptibility of nanoparticles to small changes in the nanoparticle environment, which confers their unique properties for detection and sensing, as probes at the biomolecular scale. In addition, as many of the sensing is performed ex-vivo, and onto supported sensing devices, exposure is minimal and thus risks. Needless to say, early and accurate diagnosis save lives and it has been most likely the main reason for the increase of life quality and expectation in cancer patients in the last decades. Better diagnosis with similar therapies. Related to this, researchers developed cancer nanotechnologies for the **Diagnosis through breath**. Back in 2006 researchers established that dogs could detect cancer by sniffing the exhaled breath of cancer patients. Now, using nanoscale arrays of detectors, two groups of investigators have shown that a compact mechanical device also can sniff out lung cancer in humans. Researchers used a network of 10 sets of chemically modified carbon nanotubes to create a multicomponent sensor capable of discriminating between a healthy breath and one characteristic of lung cancer patients. Meanwhile, another team, and his colleagues used a commercial nanoarray-based electronic “nose” to discriminate between the breath of patients with non-small cell lung cancer and chronic obstructive pulmonary disease. Similarly, an unlikely multidisciplinary scientific collaboration has discovered that an electronic nose developed for air quality monitoring on Space Shuttle Endeavour can also be used to detect odour differences in normal and cancerous brain cells. The results of the pilot studies open up new possibilities for neurosurgeons in the fight against brain cancer. The electronic nose, which is to be installed on the International Space Station in order to automatically monitor the station's air, can detect contaminants within a range of one to approximately 10,000 parts per million.

Not being enough, the substitution of the sensing carbon nanotubes by gold nanoparticles developed an improved **Cheap, Fast, Portatil and Performant Lung Cancer Nanobiosensor**. In miniaturization, mimicking the sense of smell has been a major target. The Smell is composed of thousands integrated specific receptors, in fact, the Smell occupies over a thousand of gens and such a huge analyzing library has to be shrieked to fit in a body. With nanotechnology success is closer: already, using carbon nanotubes these principles have been tested and verified. Now, changing the material, using gold nanoparticles the results have improved. Conventional diagnostic methods for lung cancer are unsuitable for widespread screen-

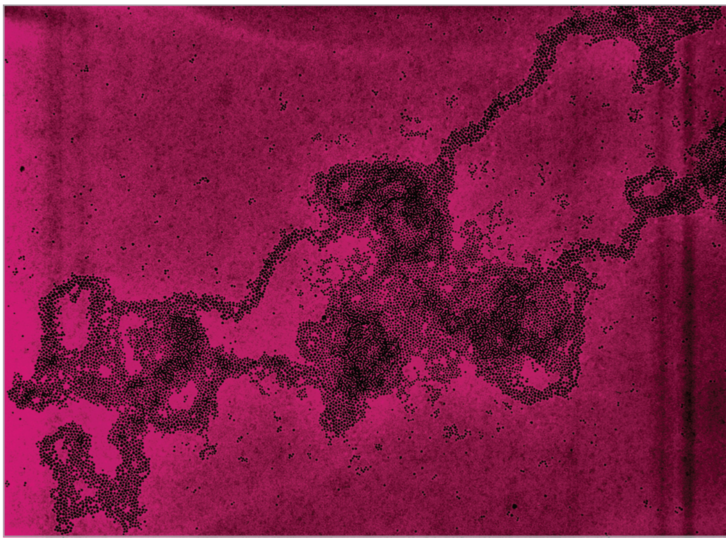


plate 28 : Soft & Silk

ing because they are expensive and occasionally fail to detect tumors. Gas chromatography/mass spectrometry studies have shown that several volatile organic compounds, which normally appear at levels of 1–20 ppb in healthy human breath, are elevated to levels between 10 and 100 ppb in lung cancer patients. Authors showed that an array of sensors based on gold nanoparticles can rapidly distinguish the breath of lung cancer patients from the breath of healthy individuals in an atmosphere of high humidity. In combination with solid-phase microextraction, gas chromatography/mass spectrometry was used to identify 42 volatile organic compounds that represent lung cancer biomarkers. Similarly, in 2009 the **First use of label-free nanosensors with physiological solutions** was announced where researchers used nanosensors to measure cancer biomarkers in whole blood for the first time. Their findings could dramatically

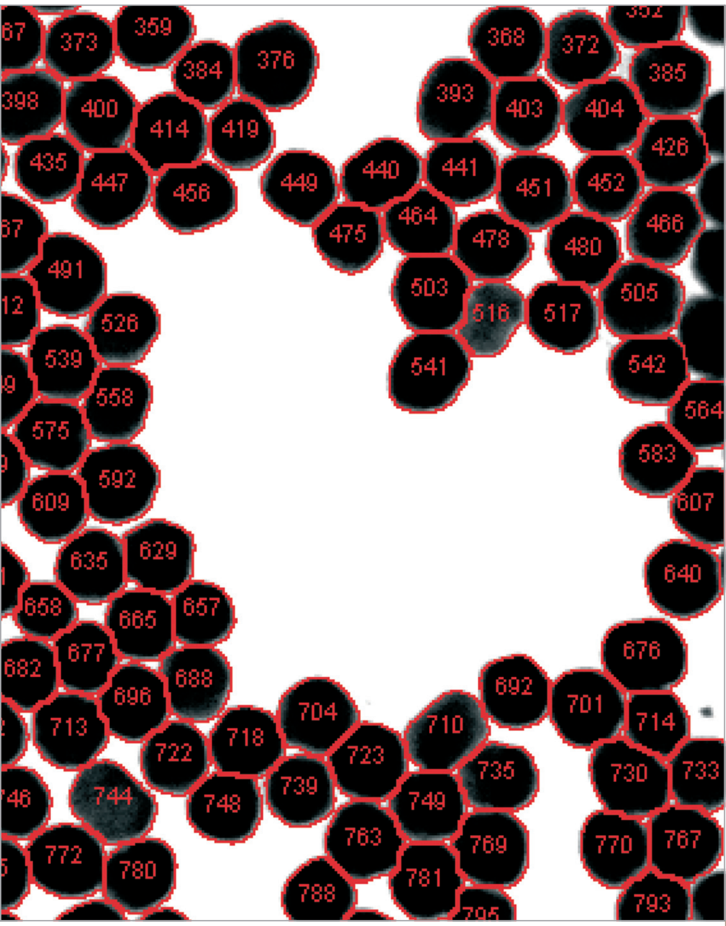


plate 7 : Cobalt Nanoparticles Seized in red 3

simplify the way physicians test for biomarkers of cancer and other diseases. “Nanosensors have been around for the past decade, but they only worked in controlled, laboratory settings,” authors said. The chip allows for detection down to extremely small concentrations, on the order of picograms per milliliter, to within an accuracy of plus or minus 10 percent. This is the equivalent of being able to detect the concentration of a single grain of salt dissolved in a large swimming pool. Doctors could have these small, portable devices in their offices and get nearly instant readings,” authors said. “They could also carry them into the field and test patients on site. A revolutionary way of diagnosing tumor cells came with the study of the refractive index of the cells at the nanometric scale. In fact, researchers announced that **Nanoscopic changes to pancreatic cells reveal cancer** using what they called partial wave microscopic spectroscopy, based on scanning probe microscopy principles. The new technique works by detecting fluctuations in the cell's refractive index (an optical property that measures how cells bend light passing through them). These fluctuations are influenced by nanoscopic changes to the cell’s interior architecture that often occur much earlier than the changes pathologists can detect under their microscopes. The more architectural disorder there is inside the cell, the more the refractive index fluctuates. Partial wave microscopic spectroscopy may be a boon to medicine, if it proves effective in clinical trials at detecting cancers early — especially for people with pancreatic cancer, which is one of the most deadly forms of cancer.

plate 9 : Gold Amalgam 2, the kiss

# Nanotechnology versus Cancer. The Next Present

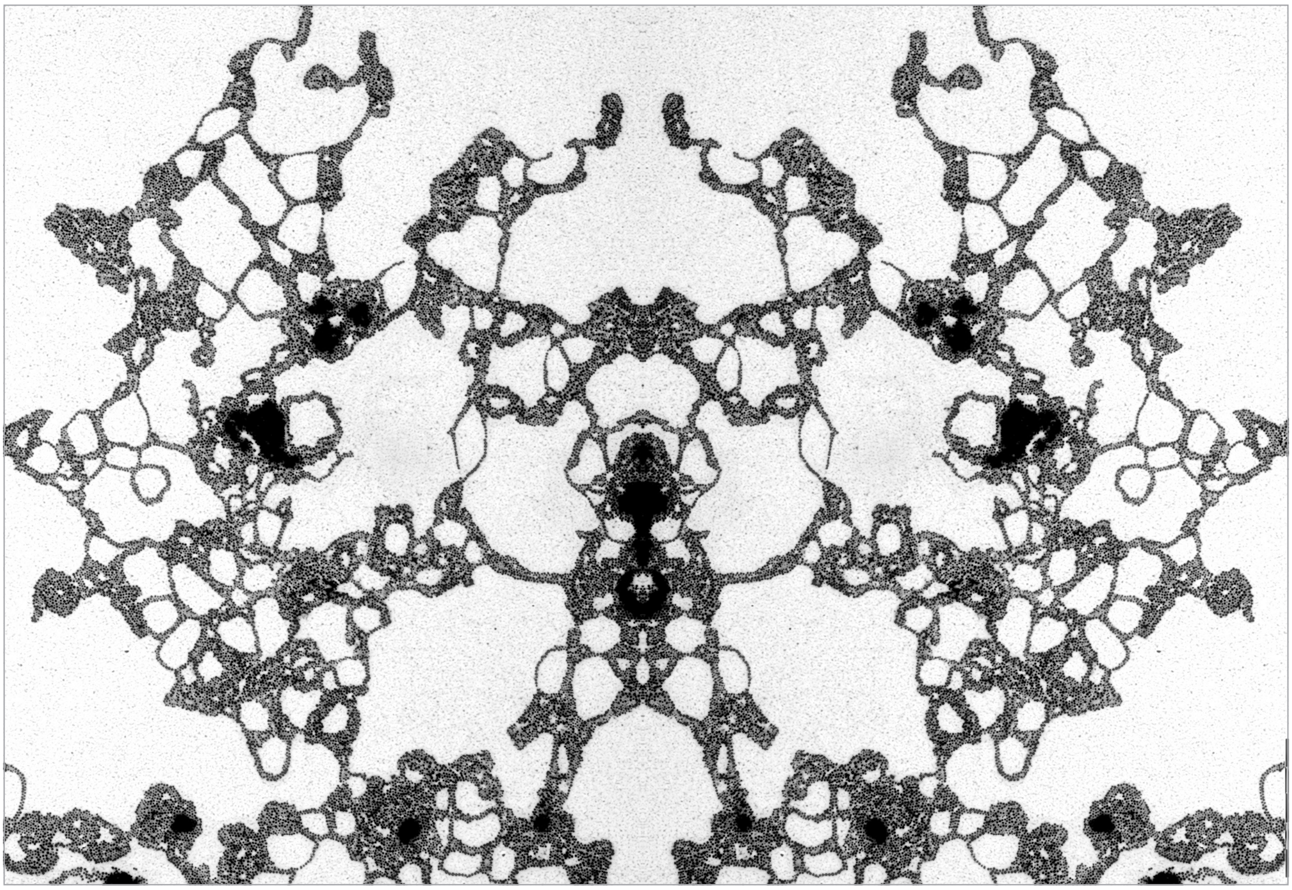
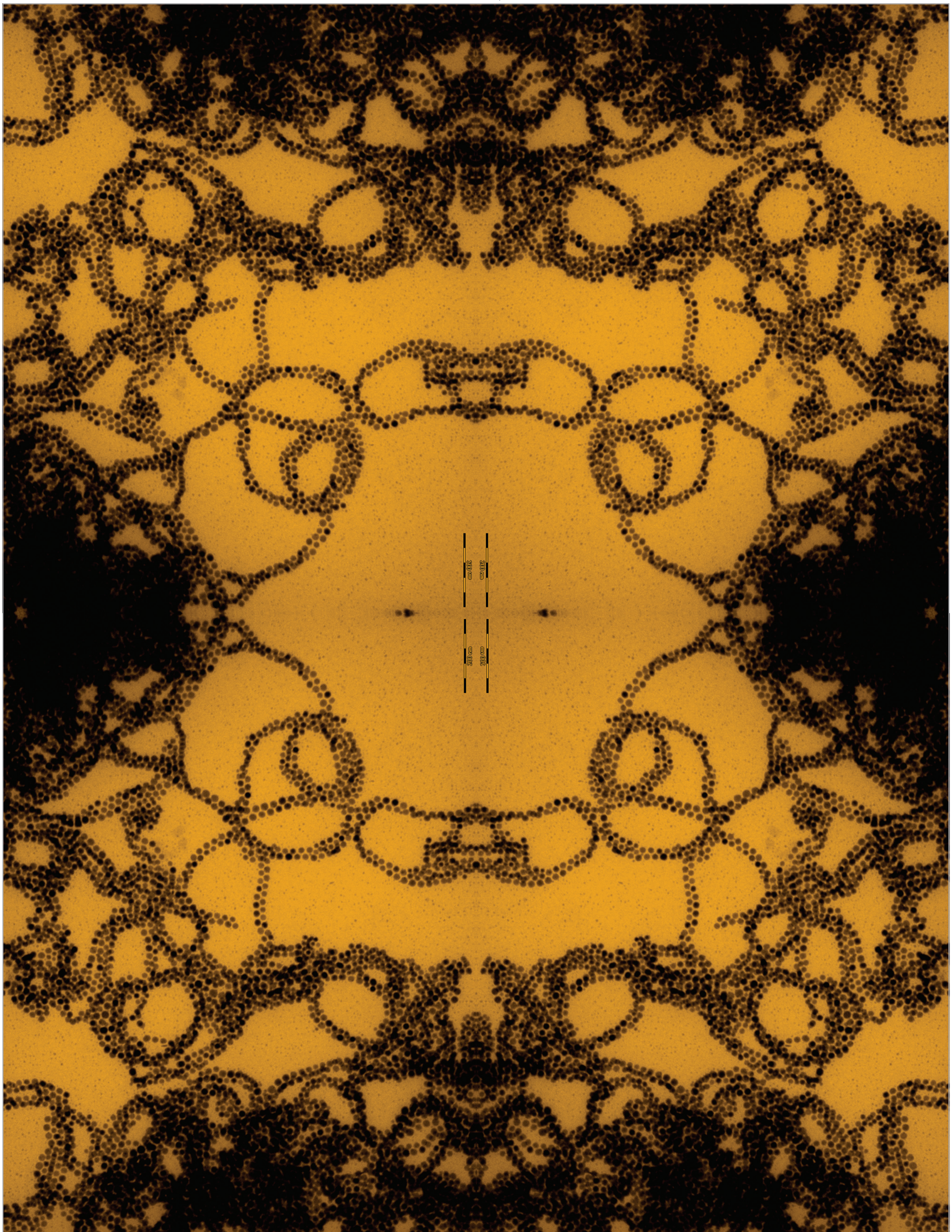


plate 37 : Seing Myself

It is in fact in Cancer where the first uses in nano-medicine are expected. Threre are few reasons for this, which include the severity of the disease, the maturity of the experimental models and the ability to easily monitor improvements and the accepted general idea of lack of breakthroughs in clinical treatment of Cancer despite progress in its understanding. Hopefully, improvements brought by nanotechnology in the clinical treatment of Cancer will narrow the gap between nanoscience and society. Last year (2009), the **Final clinical trials for Nano-Cancer® therapy** was announced by MagForce Nanotechnologies AG, the Berlin-based medical technology company. They announced the successful completion of final trials demonstrating the efficacy of magnetic hyperthermia in patients with recurrent glioblastoma, a frequent form of brain tumor which is highly malignant. The actual study results significantly exceeded the study objective. In fact, the median survival time of the 59 patients participating in the final trials was 13.4 months following treatment with Nano-Cancer® therapy in conjunction with radiation. The median survival time was thus significantly greater, more than double compared to that of the control population. The results were even more remarkable because the Nano-Cancer® therapy was tested not on newly diagnosed patients with primary tumors but rather as a study involving patients who had already endured treatment with conventional therapies, as well as the unpleasant effects generally associated with these. A responsible of the work said: "we may thank nanotechnology for an historical advance in medical science". To learn more about the possibilities of nanotechnology in cancer and explore the field, visit the **Video Journey Into Nanotechnology** from the National Cancer Institute. As they say, in the fight against cancer, nanotechnology introduces unique approaches to diagnosis and treatment that could not even be imagined with conventional technology. New tools engineered at sizes much smaller than a human cell will enable researchers and clinicians to detect cancer earlier, treat it with much greater precision and fewer side effects, and possibly stop the disease long before it can do any damage. Imagine

a nanoparticle that can be used to light up a tumor in a MRI (Magnetic Resonance Imaging) device, destroy cancer cells by converting magnetic fields into heat, and allow the physician to visually track the progress of treatment. Together with this, many researchers are actively working on the diagnosis and treatment of cancer with nanotechnology and radical improvements are expected in the next decade where cancer may mutate from acute to chronic disease.

plate 40 : Nanomandala



# NanoImmune. The Near Future

If nano and cancer developments are already well established and very close to clinical application, an emerging field appears to be the interaction between nanomaterials and nanostructures and the immune system, a discontinuous organ responsible to fight invasion and infection, as well as allergy, cancer and rejection (a system which recognizes biological patterns to discern between invaders from self). Cells of the innate immune system are provided with a series of transmembrane Pattern Recognition Receptors that beyond a chemical composition detect a specific biological structure, as antibodies binds to specific biological structures at the short nanometric level (about or below 10 nm). How do we go **from chemistry to biology? Nanotechnology**. If we look at the atomic composition of a life form in earth, it is rather poor, C,H,O,N, which forms 95%of the biomass, and few more at very low concentrations. Irrelevant market price. If we look at it from the chemical point of view, the view is not improving radically: from the geranium to the elephant everything is built up with about 20 building blocks which share two chemical characteristic functions (amino group and carboxylic acid), and some of the 20 are not very abundant. However, from the biological point of view, the richness of life forms is vast: they can fly, emit light, glow discharges and be latent for hundreds of years before blossom again. In addition, life can reproduce and evolve, process and compute much more than all computers together. But, how do we go from chemistry to biology? At which moment the redundant and flat chemical composition of life forms is transformed into amazing structures? The answer is: at the nanometer level. It is the molecular organization at the nanometric scale which confers biological entity to chemical compounds, ist est, life emerges at the nanolevel. Following these ideas, two papers recently showed how short peptides which had no biological relevance can become strongly immunogenic when they were arranged on top of a gold nanoparticle. And the degree of immune activation depended on the topological order of the peptide array, where the more ordered are the more bio-active, while the random peptidic coating of a gold nanoparticle did not elicit any biological response. In this study murine bone marrow macrophages were able to recognize gold nanoparticle peptide conjugates, while peptides or nanoparticles alone were not recognized. Consequently, in the presence of conjugates, macrophage proliferation was stopped and

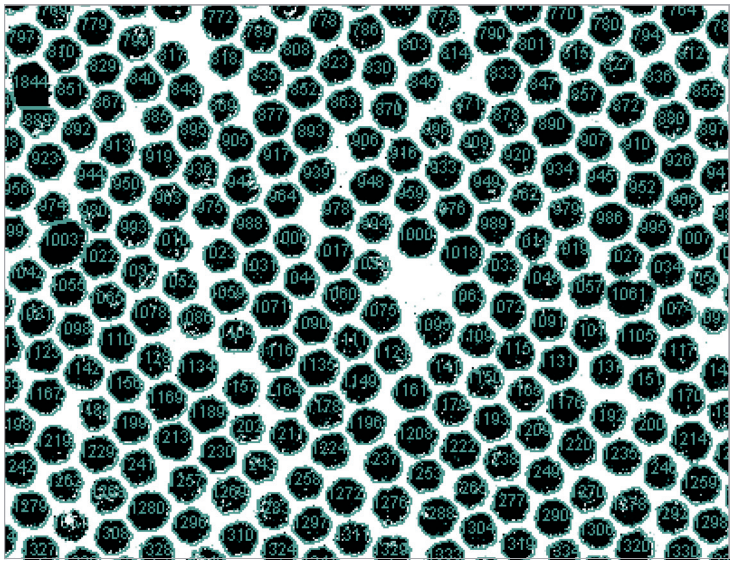


plate 4 : Seized Cobalt Nanoparticles 2

pro-inflammatory cytokines were induced. Furthermore, macrophage activation by gold nanoparticles conjugated to different peptides appeared to be rather independent of peptide length and polarity, but strongly dependent on peptide pattern at the nanoparticle surface. Correspondingly, the biochemical type of response also depended on the type of conjugated peptide and could be correlated with the degree of ordering in the peptide coating. These findings help to illustrate the basic requirements involved in medical nanoparticle conjugate design to either activate the immune system or hide from it, in order to reach their targets before being removed by phagocytes, which must rapidly distinguish between self and non-self molecules to protect the host from succumbing to infections. Relating nanotechnology and immunology, virus detection, vaccine, adjuvants and anti-infectious drugs were also reported in **Influenza detection systems, vaccine and nanoviricide anti-influenza drug**. First, a new form of nanotechnology based infectious disease detection system with the capability to distinguish between different flu strains within seconds was described. The technology showed to be effective in lab tests. “With current disease identification technologies requiring blood samples to be shipped to a laboratory for testing, distinguishing between pandemic strains and common ones can take up to twenty-four hours. Our technology has the potential to reduce this to under a minute, requires either a pin prick of blood or a saliva sample and will deliver the result of the diagnoses on the spot.” The

technology is based on printed electronics, making use of the unique properties of a number of nano-particle based inks and it is rapid and accurate. The hand-held device is easily portable for use in doctor surgeries, hospitals or airports. These nano-detection systems work for both bacterial and viral pathogens. Besides, data was presented at the National Foundation of Infectious Disease (NFID) which supported new insight into a technology that could provide more safe and effective vaccines for a wide variety of diseases. Results of the study show that the desired immune response elicited by a vaccine can be enhanced up to 10-fold when the vaccine protein is linked to nanoparticles of a particular size and shape. Particles mimicking the size and shape of pathogens may improve the safety and efficacy of vaccines. The discovery may lead to a new generation of vaccines that could provide faster immunity to disease and potentially minimize the need for multiple vaccinations or

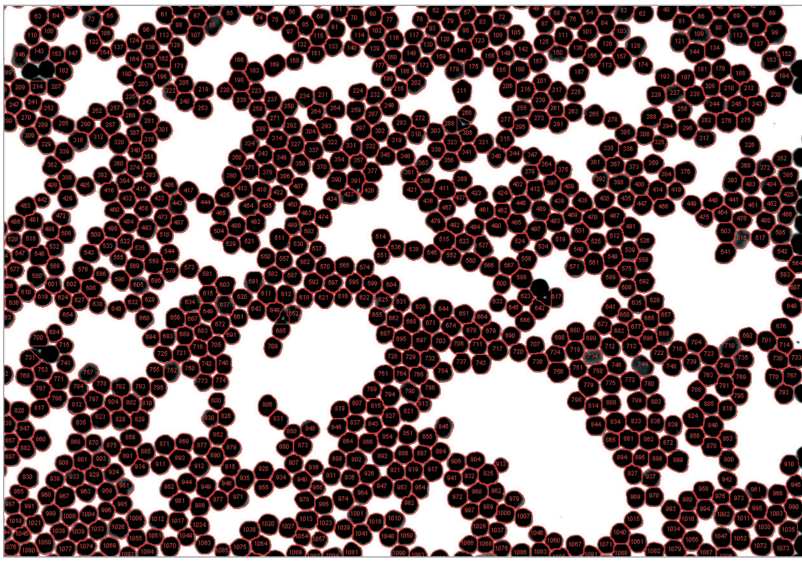
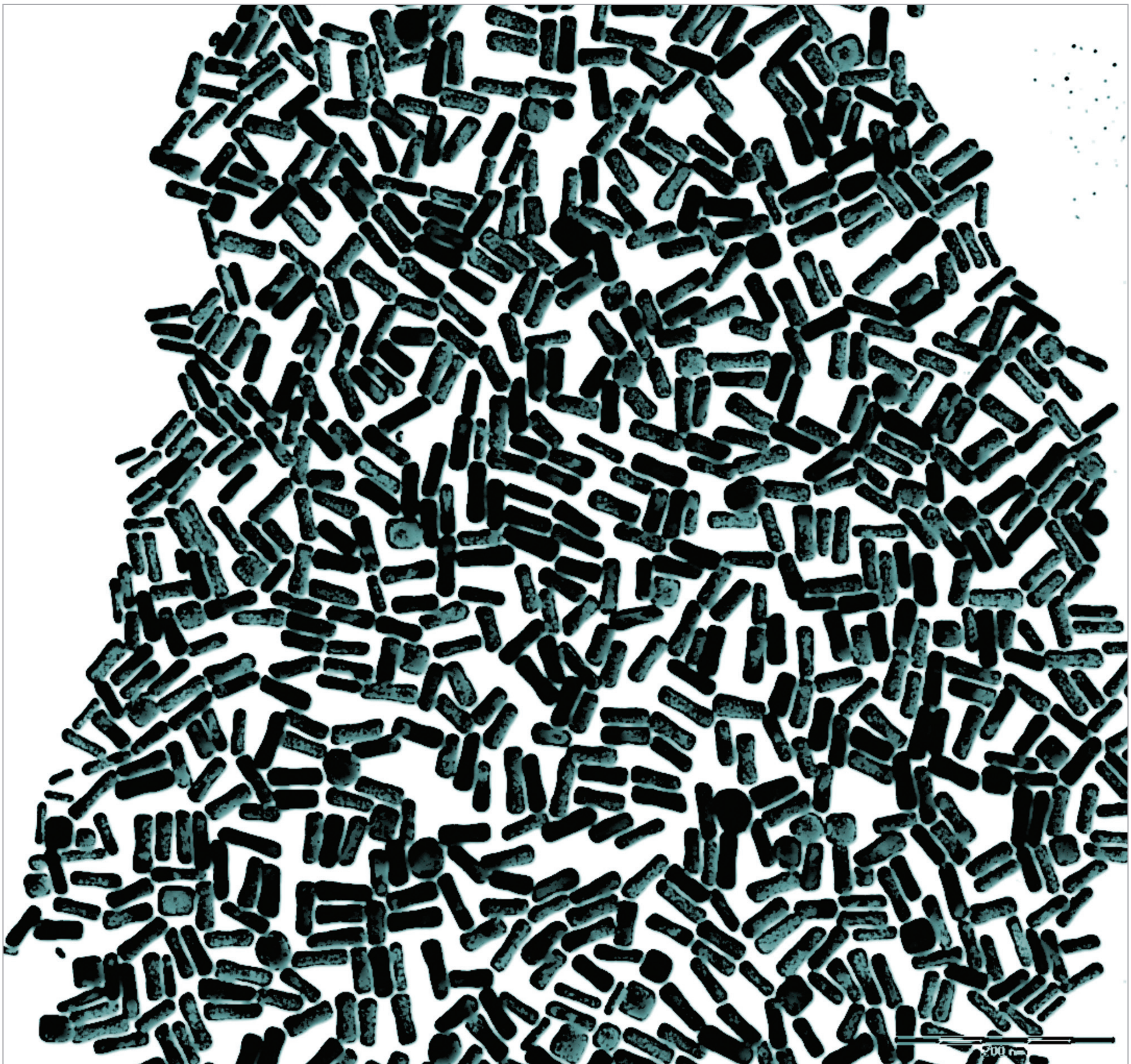


plate 6 : Cobalt Nanoparticles Seized in red 2

"booster shots." Also during the year 2009, Nano-Viricides announced that it is developing FluCide, to work against all influenza types and subtypes. FluCide has been shown to be effective against both common influenza subtype H1N1, as well as

plate 42 : Gold Bricks and Stones



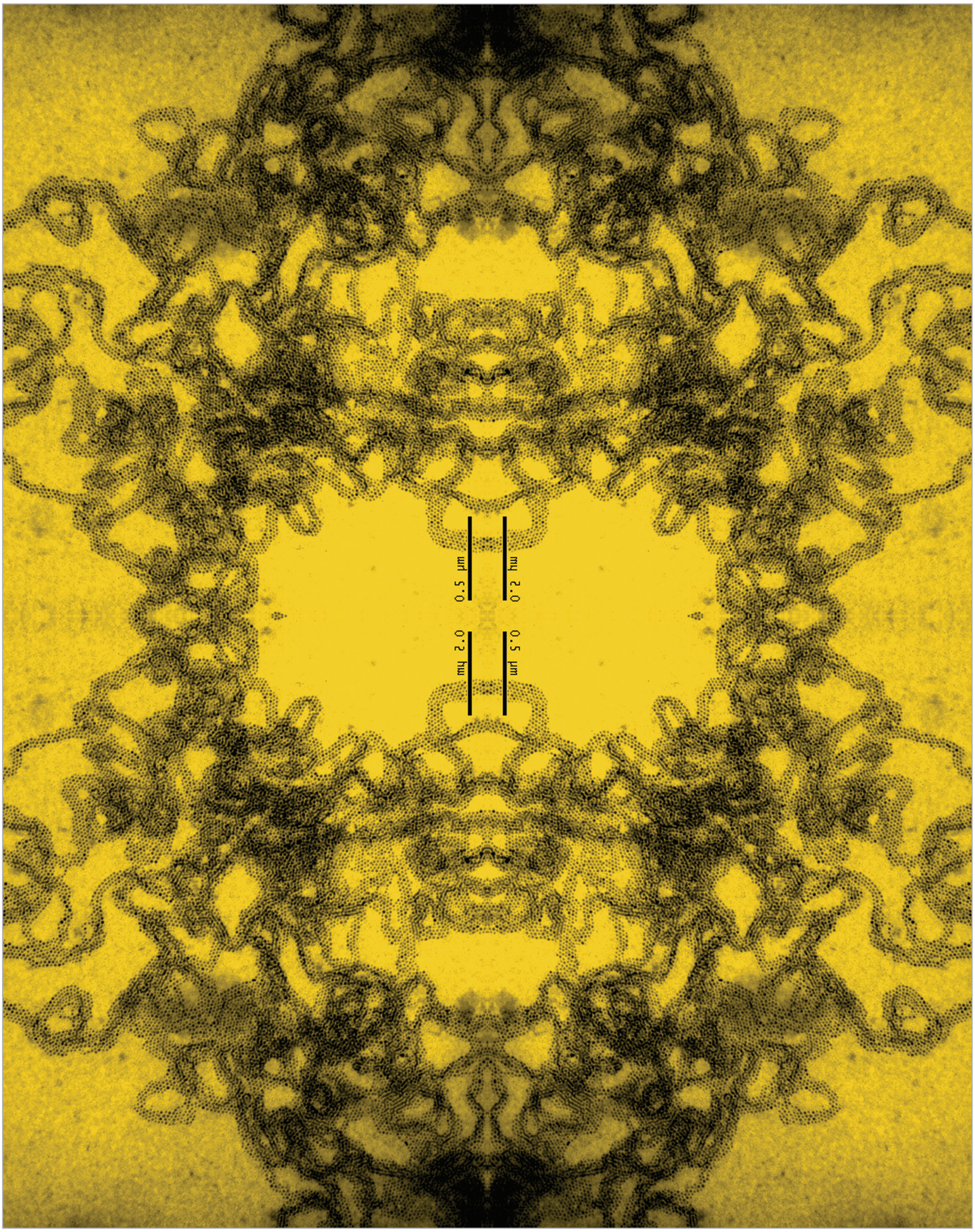



plate 10 : Infinite is in all directions

two different variants of bird flu subtype H5N1. If these results are confirmed in further animal and human studies, thenFluCide would most likely be considered the best ever drug effective against all influenzas. All this news indicating the coming development of the nanoimmune field, also regarding toxicity, since the immune system is responsible for maintaining body integrity and preventing external invasion. Consequently, a profound understanding of the interaction between nanoparticles and the immune system is needed if additional applications based on those materials have to be developed.

# Exploring new pathways in nanomedicine

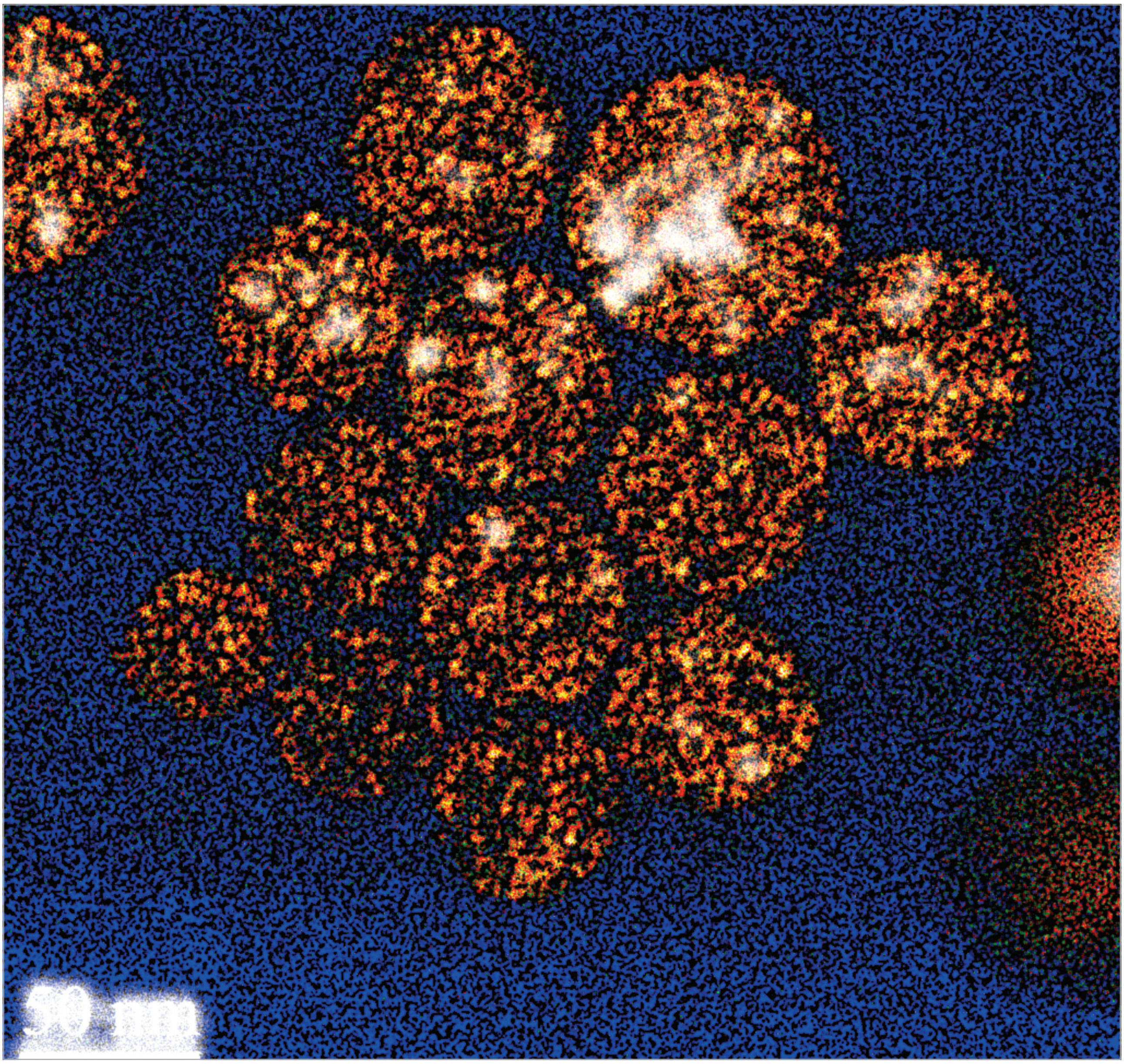
plate 2 : Platinum mossaic 2

Getting back to the beginning, finding answers to many of these questions start studying the **Interaction between nanomaterials and biological systems** from broad and comprehensive points of view, as the initiative lead by researchers at UCLA and the California NanoSystems Institute (CNSI), along with colleagues in academia and industry, taking a proactive role in examining the current understanding of the nano-bio interface to identify the potential risks of engineered nanomaterials and exploring design methods that will lead to safer and more effective nanoparticles for use in a variety of treatments and products. For example, other surprising application of nanoparticles is the use of **Nano-magnets to guide stem cells to damaged tissue**. Microscopic magnetic particles have been used to bring stem cells to sites of cardiovascular injury in a new method designed to increase the capacity of cells to repair damaged tissue. Although magnetic fields have been used to guide cellular therapies, this is the first time cells have been targeted using a method directly applicable to clinical practice. The technique uses an FDA (US Food and Drug Administration) approved agent (iron oxide superparamagnetic nanoparticles stabilized with dextran) that is already been used to monitor cells in humans using MRI (magnetic resonance imaging), solving a major problem of regenerative medicine which is seeding the stem cells at the target location. On the exotic side of biological applications brought about by nanotechnology, and related to hyperthermia, there is the use of light (of any wavelength) to manipulate molecules, often using a nanoparticle as antenna or contrast agent. An appealing case is the **Light-driven nanomotor built with a single molecule of DNA** where a team of chemists reported a new type of “molecular nanomotor” driven only by photons built entirely with a single molecule of DNA — giving it a simplicity that increases its potential for development, manufacture and real-world applications in areas ranging from medicine to manufacturing. In the coming years, the nanomotor could become a component of microscopic devices that repair individual cells or fight viruses or bacteria, authors said. Because it is made of DNA, the nanomotor is biocompatible. Unlike traditional energy systems, the nanomotor also produces no waste when it converts light energy into motion. To make the nanomotor, the researchers combined a DNA molecule they created in the lab with azobenzene, a chemical compound that

responds to light. A high-energy photon prompts one response; lower energy another. To demonstrate the movement, the researchers attached a fluorophore, or light-emitter, to one end of the nanoengine and a quencher, which can quench the emitting light, to the other end. Their instruments recorded emitted light intensity that corresponded to the motor movement. “Radiation does cause things to move from the spinning of radiometer wheels to the turning of sunflowers and other plants toward the sun.”

Finally, two ideas can already be withdrawn, there is not a simple and universal answer regarding nanoparticle toxicity, as it cannot be a simple and universal answer regarding toxicity of chemistry, or physics. Some things are and other are not. Researchers need to find which ones and depending on what. Besides, it seems that the medical applications require a degree of design and extremely careful manipulation in such a way that any unintended exposure to real and reasonable concentrations of nanoparticles will be degraded and detoxified in the environment without presenting ungovernable risks.

plate 11 : Cobalt Gold Supernova Bouquet



# Nanotechnology and Society

As it has been mentioned earlier, the introduction of a new technology in society combines scientific and social forces. To observe the introduction of nanotechnology in society, consumer products including nanotechnology is a good reference. Nanotech consumer products have now crossed the millennial threshold, **Nanotech-enabled Consumer Products Top the 1,000 Mark**, though there are more and wilder things out there in the internet market, as the spermicide foam with Ag nanoparticles for intravaginal application as contraception method. Over 1,000 nanotechnology-enabled products have been made available to consumers around the world, according to the Project on Emerging Nanotechnologies (PEN). The most recent update to the group's three-and-a-half-year-old inventory reflects the increasing use of the tiny particles in everything from conventional products like non-stick cookware and lighter, stronger tennis rackets, to more unique items such as wearable sensors that monitor posture together with a real nano-invasion in cosmetics, often with nothing more nano than the label or the ubiquitous Ag and Au nanoparticles. This will provide significant oversight challenges for agencies like the Food and Drug Administration and Consumer Product Safety Commission. Health and fitness items continue to dominate the PEN inventory, representing 60 percent of products listed. More products are based on nanoscale silver—used for its antimicrobial properties—than any other nanomaterial; 259 products (26 percent of the inventory).
In this context of industry selling while scientist are still wondering, it is essential, and nanowiki seeks to promote it, to establish a **Debate on Nanotechnology Responsible Development**. A new report by a group of leading European academics, argues that decision-making on science - especially regarding emerging technologies such as nanotechnology - must become more democratic. The report, "Reconfiguring Responsibility", was the result of a three-year research project funded by the European Commission as part of the DEEPEN (Deepening Ethical Engagement and Participation in Emerging Nanotechnologies) project. The authors strongly suggest that current governance activities are limiting public debate and may result in a repeat of the mistakes made in managing genetically modified foods. "I believe that involving the public in decision making on science can lead to better outcomes – as well as being fascinating and rewarding for the scientists involved. If we are to continue to make nanotechnology a more socially responsible science we need to build on research such as that discussed in the 'Reconfiguring Responsibility' report."

plate 35 : Sharp Crystalline Hortensias

# Learning Nanotechnology

Finally, as simple as essential, the teaching of nanotechnology has to increase dramatically in order to provide enough experts for its implementation. Nowadays different universities around the globe are organizing degree and master lectures on nanotechnology by choosing teachers from biology, chemistry, physics and others. This situation of newness is ideal for research but complicates teaching. Who teaches the teachers? With this new-found knowledge comes an imperative to

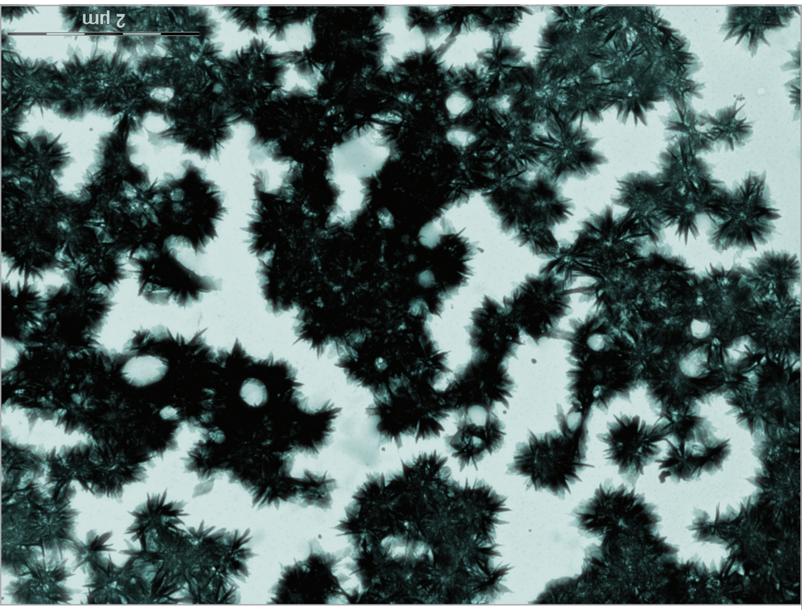


plate 32 : Eaten Sea Oursins

change the way we teach science. To address these issues a new **Journal of NanoEducation (JNE)** has appeared. What makes JNE unique among the many other established journals that focus on teaching and learning in the various scientific, technological, engineering and medical disciplines is based on the fact that research in nanoscale science inherently is an interdisciplinary endeavor. In particular, an overarching goal of JNE is to become a recognized leader in the development of a coherent, integrated knowledge base on nanoscale science, technology, engineering and medical education. As persuasively argued, “one of the ‘grand challenges’ for nanotechnology is education, which is looming as a bottleneck for the development of the field, and particularly for its implementation”." Questions arise asking if nanoscale science and engineering is truly a separate field of study; are we creating another layer in our educational system, or can nanotechnology be infused into our current science, technology, engineering, and mathematics educational system? Nanotechnology is really not a new and separate field, but involves the basic building blocks of our world -atoms and molecules. Nanoscale science and engineering are rooted in the core concepts of science. What it is photosynthesis? Photochemistry, chlorophyll, biology, or quantum physics? Teachers do not need to add anything new to what they are teaching, but rather they can introduce nanotechnology into concepts they are already teaching. Nanoscale science and engineering crosses all disciplines and is truly an interdisciplinary field. This requires that we teach science not as compartmentalized subjects, but as concepts that have connection with each other. We must teach our students to be able to make connections between nanotechnology and the different scientific fields, which in turn requires that we teach our teacher candidates to make these same connections. Teachers also need exposure to inquiry methods, critical thinking, and problem solving and how to incorporate these into their teaching strategies. Furthermore, nanoscale science and engineering can serve as a catalyst to excite students about science, technology, engineering, and mathematics. However, to do this will require that we continue to enhance our efforts to communicate the importance of nanoscale science and engineering to all members of our society.

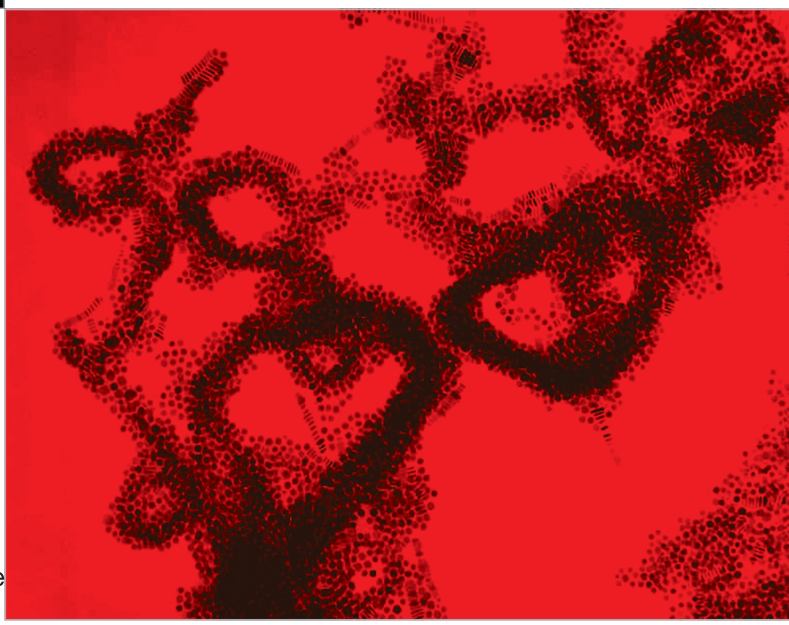


plate 20 : Birds in love

Victor Puntes and the Inorganic Nanoparticles Group, January 2010

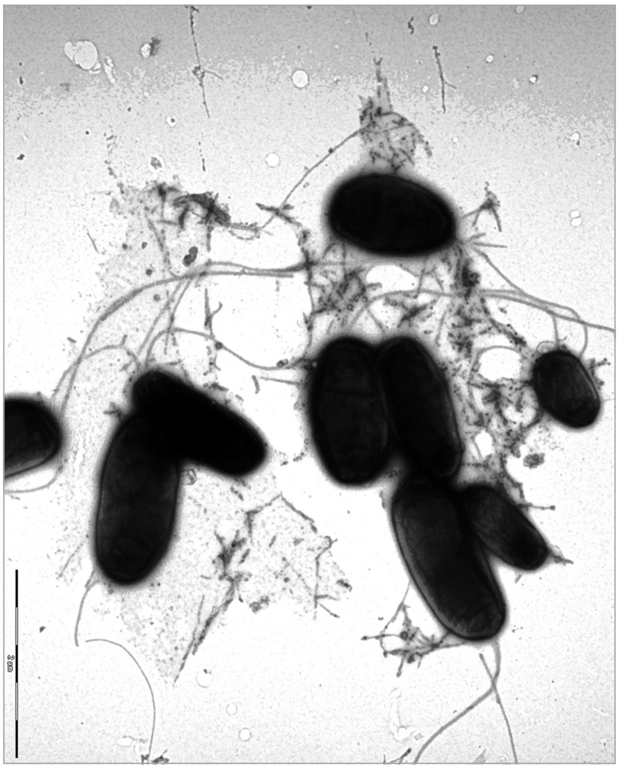
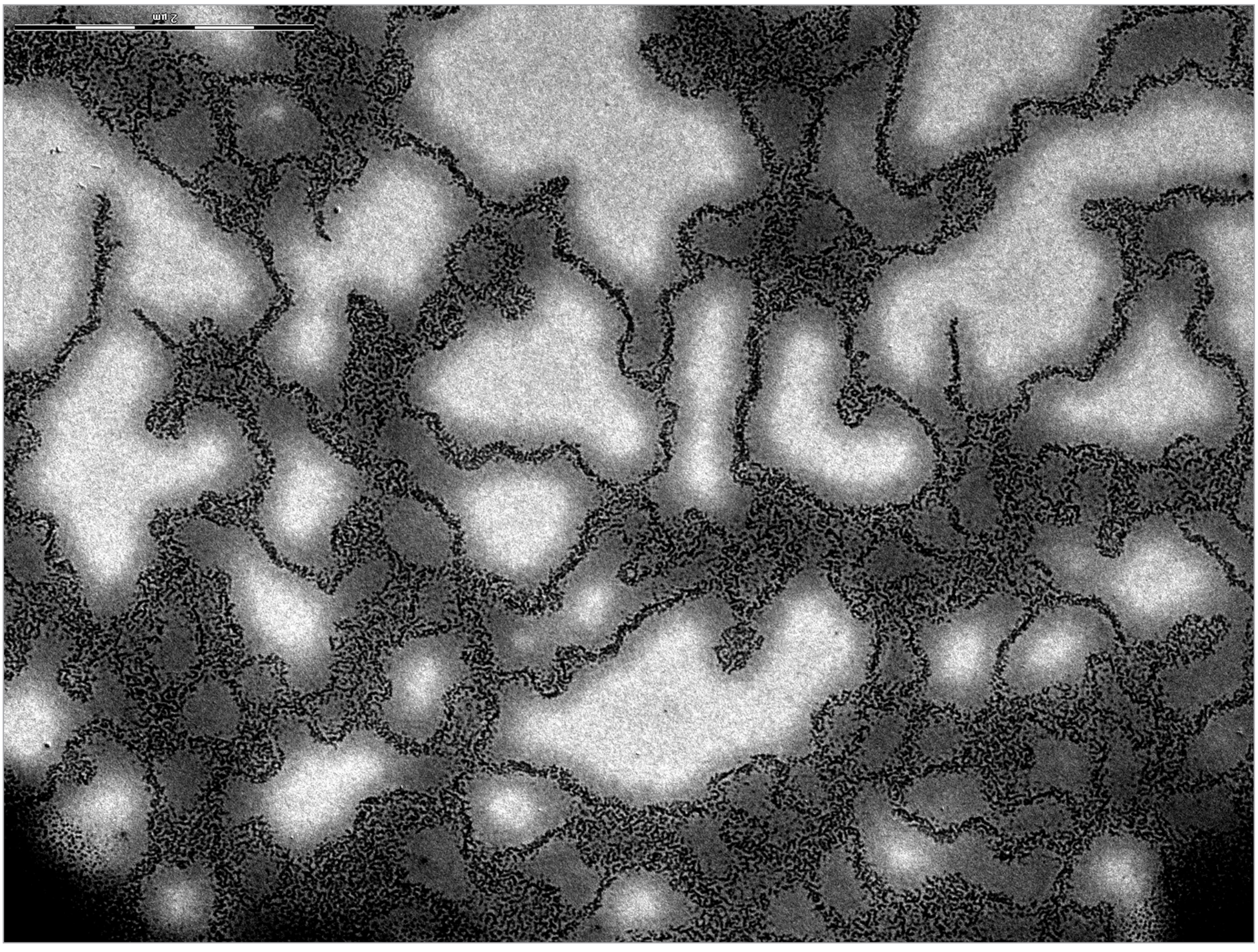


plate 27 : Bacillus Eating Proteins Dressed with Gold Nanoparticles

plate 25 : Dancing Chicken

plate 30 : Smoke gets… 2



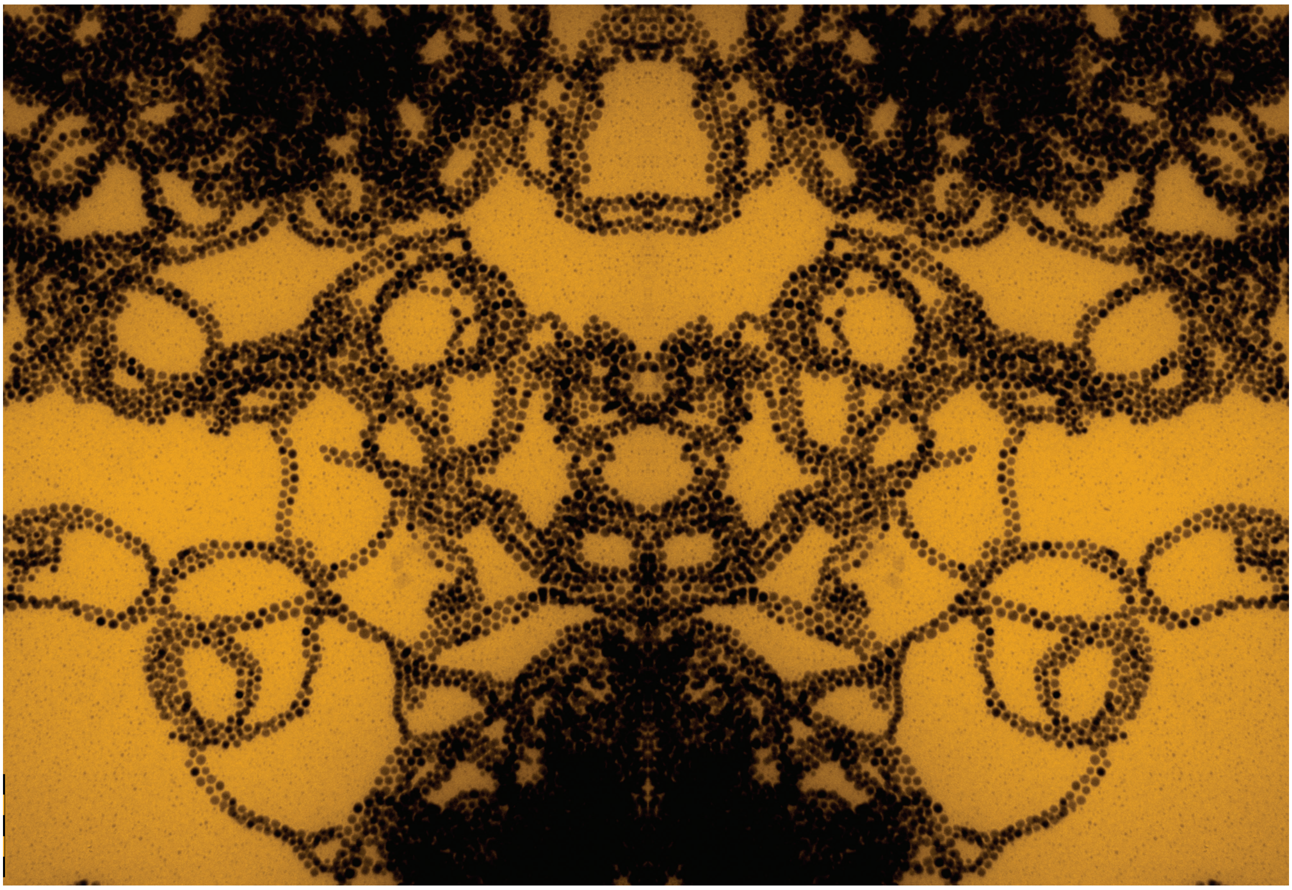


plate 39 : Oriental Rug

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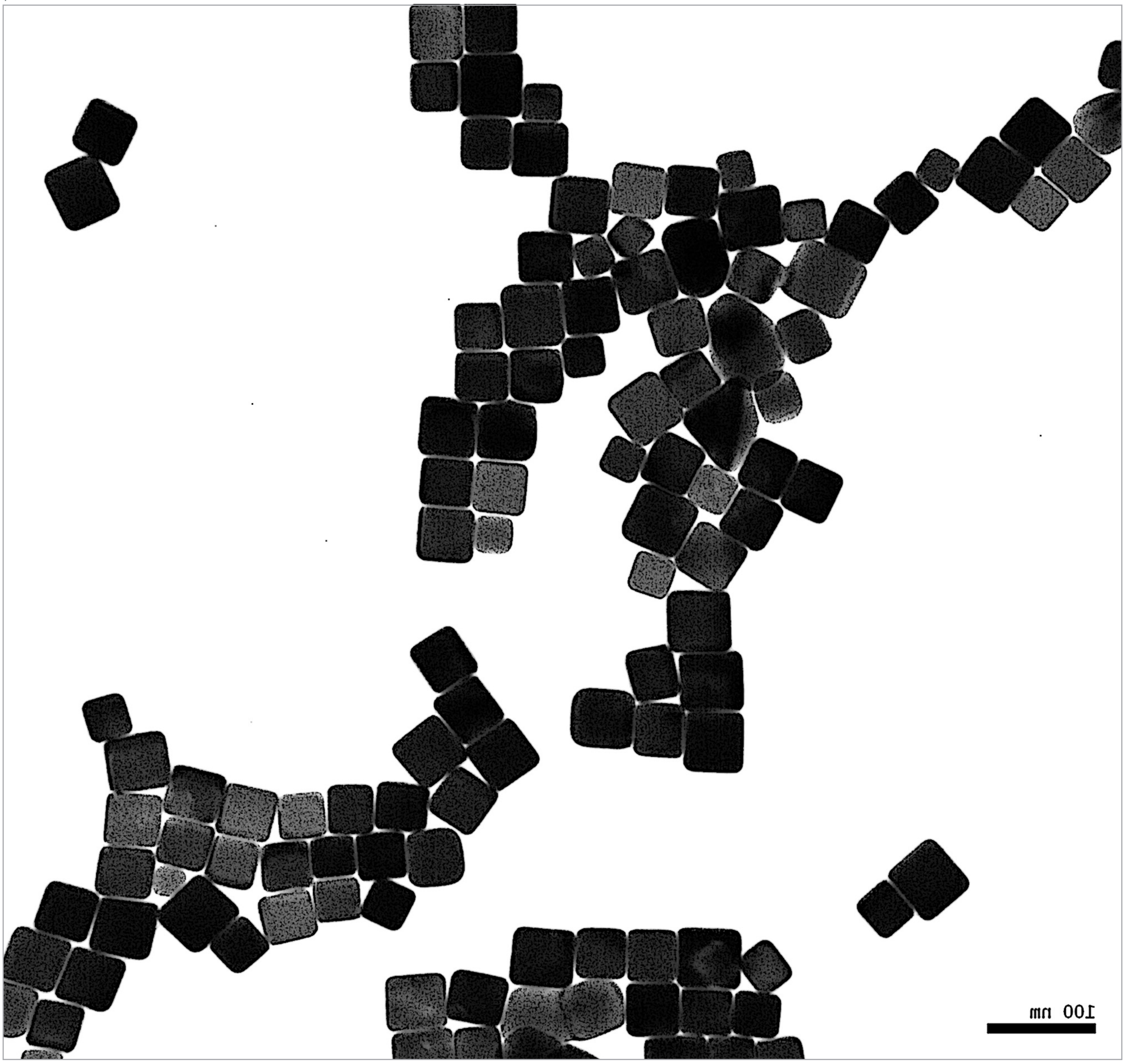
>>> tracking nanotechnology

plate 15 : The Acrobat



# news NanoWiki

# Linking nanoparticle exposure to pulmonary fibrosis and mortality

josep saldaña, 19 August 2009 (created 19 August 2009)
tags: nanotoxicology + nanoparticles + concerns

**A study has for the first time claimed a concrete link between exposure to nanoparticles in adhesive paint and development of severe pulmonary fibrosis in a group of young female workers; two of whom went on to suffer fatal lung failure.**

Toxicity from nanoparticulates has been the topic of increasing research effort for several years. For some nanoparticles and nanomaterials, toxicity has already been established in animals. For example, mice were found to develop symptoms of inflammation and pulmonary fibrosis following application of carbon nanoparticles to the trachea (Lam et. al, 2004). However, **until now no cases have been reported in humans.** The work of a Beijing-based group of scientists in the European Respiratory Journal linking exposure to nanoparticles in adhesive paint to severe pulmonary fibrosis in a group of young female workers therefore breaks new ground in the area, providing fascinating new evidence for consideration in the debate on the dangers of nanotechnologies.

The study, by a team led by Yuguo Song, of the Occupational Disease and Clinical Toxicology Department at Chaoyang Hospital in Beijing, involved seven healthy young women employed in a print plant. Over the course of a few months, all of the women were hospitalised for respiratory problems, accompanied by itchy eruptions of the skin on the face and arms. On examination, the patients were found to have liquid effusion around the heart and lungs, which proved resistant to all treatments. Comprehensive investigation led to a diagnosis, in all cases, of pulmonary fibrosis with consequent impairment of lung function.

The Chinese team's link between the symptoms and nanoparticle exposure was based on the results from electron microscopy of the chemical used, lung biopsy tissue and pleural effusion liquid, all three of which were found to contain round nanoparticles with a diameter of approximately 30 nanometres. Yuguo Song, the lead scientist, claims that these particles were likely to originate in the polyacrylate-based adhesive paints used by the women daily in the course of their work. However, he emphasises that despite repeated efforts, the group has not at this stage been able to obtain precise data on the composition of the paint in question. Likewise, the researchers have not been able to determine the workers' level of exposure through measurement of airborne particles, since the workshop was closed down several months before their investigation began.

"It is clear that the symptoms, the examination results and the progress of the disease in our patients differ markedly from respiratory pathologies induced by paint inhalation", Yuguo Song emphasises. Given the increasing enthusiasm for nanotechnologies, the authors urge that priority be given to protecting the public and the workforce. **"We call on scientists throughout the world to work together and address this new challenge"**, Yuguo Song concludes. Clearly, the paper's findings are set to have a huge impact on the nanotoxicology field, and potentially on the public acceptance of nano in general. **However, there are a number of issues with the evidence presented in the paper, which are causing leading nanotoxicologists to question the causal link implicated between the nanoparticle exposures and the consequent illness**.

**Source:** From Chinese researchers link nanoparticle exposure to pulmonary fibrosis in female workers. This work is detailed in the paper Exposure to nanoparticles is related to pleural effusion, pulmonary fibrosis and granuloma by Yuguo Song, X. Li and X. Du

SAFENANO has prepared a special feature on this paper (Linking nanoparticle exposure to pulmonary fibrosis and mortality. Evaluating the key messages of Song et. al.), which provides an impartial breakdown & appraisal of the study's findings in order to assist readers in forming their own opinion on its importance & implications.

# And now what? Being responsible may be too expensive?

Victor Puntes, 18 December 2009
tags: nanotoxicology + concerns + Victor Puntes

"Information about the toxicity of nanoparticles is important in determining how nanoparticles will be regulated. In the U.S., the burden of collecting this information and conducting risk assessment is placed on regulatory agencies without the budgetary means to carry out this mandate. In this paper, we analyze the impact of testing costs on society's ability to gather information about nanoparticle toxicity and whether such costs can reasonably be borne by an emerging industry. We show for the United States that costs for testing existing nanoparticles ranges from $249 million for optimistic assumptions about nanoparticle hazards (i.e., they are primarily safe and mainly require simpler screening assays) to $1.18 billion for a more comprehensive precautionary approach (i.e., all nanomaterials require long-term in vivo testing). At midlevel estimates of total corporate R&D spending, and assuming plausible levels of spending on hazard testing, the time taken to complete testing is likely to be very high (34-53 years) if all existing nanomaterials are to be thoroughly tested. These delays will only increase with time as new nanomaterials are introduced. The delays are considerably less if less-stringent yet risk-averse perspectives are used. Our results support a tiered risk-assessment strategy similar to the EU's REACH legislation for regulating toxic chemicals." **Source:** The Impact of Toxicity Testing Costs on Nanomaterial Regulation by Jae-Young Choi, Gurumurthy Ramachandran and Milind Kandlikar.

Apparently, there is no way out for this situation other than take risks. However, we could imagine another and more peaceful scenario where companies delay the aggressive and competitive commercialization of advanced products containing nanostructures until enough scientific knowledge is gathered and matured. This may take long time, I do not thing that so much, however, even if we work for the next generation, will not they be our sons? Is not that better than just contaminate the world until things like fertility is challenged and mankind enter into a decline? Why companies are selling while scientist are still wondering about the impact of nanotechnology?

Off course, it is very different to uncontrolledly disperse antibiotic nanoparticles with underwear, than using nanoparticles in critical cases in therapies or diagnosis in a controlled environment (like and hospital) applied by specialists s(as doctors).

What we have to do is very simple, that we will be able to do despite ourselves is another question.

# Contaminated site nanoremediation

josep saldaña, 3 August 2009
tags: nanoremediation + waste + nanotoxicology

While industrial sectors involving semiconductors, memory and storage technologies, display, optical and photonic technologies, energy, biomedical, and health sectors produce the most nanomaterial-containing products, nanotechnology is also used as an environmental technology to protect the environment through pollution prevention, treatment, and cleanup. This paper focuses on environmental cleanup and provides readers with a background and overview of current practice, research findings, societal issues, potential environment, health, and safety implications, and future directions for nanoremediation. We do not present an exhaustive review of chemistry/engineering methods of the technology but rather an introduction and summary of the application of nanotechnology in remediation. Nanoscale zero valent iron is discussed in more detail. We searched Web of Science for research studies and accessed recent U.S. Environmental Protection Agency (EPA) and other publicly available reports that addressed the applications and implications associated with nanoremediation techniques. We also conducted personal interviews with practitioners about specific site remediations. Information from 45 sites, a representative portion of the total projects underway, was aggregated to show nanomaterials used, type of pollutants cleaned up, and organization responsible for the site.

**Nanoremediation has the potential not only to reduce the overall costs of cleaning up large scale contaminated sites, but it also can reduce cleanup time, eliminate the need for treatment and disposal of contaminated soil, reduce some contaminant concentrations to near zero—all *in situ*.** Proper evaluation of nanoremediation, particularly full-scale ecosystem wide studies, needs to be conducted to prevent any potential adverse environmental impacts. **Source:** From Nanotechnology and *In situ* Remediation: A review of the benefits and potential risks by Barbara Karn, Todd Kuiken, Martha Otto. This article has been reviewed by the U.S. Environmental Protection Agency and approved for publication.

The Project on Emerging Nanotechnologies has produced a map - **Nanoremediation map** - showing the location of sites at which nanotechnology has been used as a remediation technology and providing some information about each site.

# GoodNanoGuide shares best practices: how to handle nanomaterials safely

josep saldaña, 3 June 2009
tags: safety practices + nanotoxicology + concerns

The Rice University-based International Council on Nanotechnology (ICON) introduced the **GoodNanoGuide, an online, community-driven wiki for information about the safe handling of nanomaterials**. The beta version of the GoodNanoGuide can be found at http://www.GoodNanoGuide.org.

Fostered by ICON, the GoodNanoGuide is a highly collaborative, interactive **resource by and for the occupational safety and nanotechnology communities, law and industry**. The GoodNanoGuide is a practical tool for people who handle nanomaterials as well as an online repository of safety protocols. It has been developed by experts from the worlds of nanotechnology, occupational safety and business and is governed by an implementation committee from North America and Europe. AllGoodNanoGuide content is freely available via the Internet. Visitors may add their comments by becoming "Community Members," and experts may contribute and edit protocols by becoming "Expert Providers."

**More than two years in development**, the GoodNanoGuide was inspired by a challenge set forth at the International Conference on Nanotechnology, Occupational and Environmental, Health and Safety: Research and Practice, in Cincinnati in December 2006. That same year, an **ICON survey** of occupational practices for handling nanomaterials revealed a great need for improved communication about best practices. "Progress in addressing the occupational health implications of engineered nanomaterials requires the open sharing of information and the development and dissemination of good guidance," said Charles L. Geraci, chief of the Document Development Branch in the Education and Information Division of the National Institute for Occupational Safety and Health (NIOSH), and coordinator of NIOSH's nanotechnology cross-sector program under the National Occupational Research Agenda (NORA). "We are pleased to see international forums of the sort offered by theICON-sponsored GoodNanoGuide and the opportunity they provide in particular for helping to disseminate NIOSH's research and recommendations, and to make users aware of our resources."

**The international nature of the GoodNanoGuide is important to its success**, said Steve Hankin, director of operations for SAFENANO, the United Kingdom's premier independent resource on nanotechnology hazard and risk. "SAFENANO is delighted to be involved with establishing and sustaining theGoodNanoGuide ," Hankin said. "The initiative complements related nanotechnology risk activities in the U.K., Europe and North America. SAFENANO sees theGoodNanoGuide as an exciting means of capturing, appraising and cascading good practice — on an international basis — to contribute to the knowledge base of nanotechnology safety."

Financial support for the development of the GoodNanoGuide beta site was provided by International Council on Nanotechnology (ICON), nanoAlberta, British Columbia Nanotechnology Alliance-Nanotech BC, Industry Canada, Institut de recherche Robert-Sauvé en santé et en sécurité du travail and NanoQuebec. **Source:** GoodNanoGuide shares best practices. International Council on Nanotechnology launches open-source wiki.

# Diagnosis through breath

josep saldaña, 14 May 2009
tags: detection + nanomedicine + nano-oncology

In 2006 researchers established that dogs could detect cancer by sniffing the exhaled breath of cancer patients. Now, using nanoscale arrays of detectors, two groups of investigators have shown that a compact mechanical device also can **sniff out lung cancer in humans**. Hossam Haick, Ph.D., and his colleagues at the Israel Institute of Technology in Haifa, used a network of 10 sets of chemically modified carbon nanotubes to create a multicomponent sensor capable of discriminating between a healthy breath and one characteristic of lung cancer patients. Meanwhile, Silvano Dragonieri, M.D., University of Bari, Italy, and his colleagues used a commercial nanoarray-based electronic “nose” to discriminate between the breath of patients with non-small cell lung cancer and chronic obstructive pulmonary disease (COPD). **Source: Nanosensor Arrays "Smell" Cancer**. The results of Dr. Haick’s team’s work appear in the paper Detection of nonpolar molecules by means of carrier scattering in random networks of carbon nanotubes: Toward diagnosis of diseases via breath samples. Dr. Dragnieri and his colleagues published their work in the paper An electronic nose in the discrimination of patients with non-small cell cancer and COPD.

"Blood tests and urinalysis are the golden standard to identify a decline in kidney filtration, wherein high levels of creatinine and blood urea nitrogen usually reflect renal dysfunction – however, these tests tend to be highly inaccurate and may remain within the normal range even while 65-75% of kidney function is lost." Hossam Haick tells Nanowerk. "Given the difficulties in separating healthy renal function from dysfunction, it is perhaps not too surprising that precise biochemical or clinical criteria for diagnosis of acute renal failure have been elusive. Therefore, there is an unmet need for a noninvasive method for detection of renal failure of various etiologies. Furthermore, the challenge remains to diagnose renal disorders with sufficient sensitivity and specificity to provide a large-scale screening technique, feasible for clinical practice, for people at increased risk of developing renal dysfunction." Haick, Zaid Abassi and coworkers from Technion used an experimental model of end stage **renal disease** (ESRD) in rats to identify by advanced, yet simple nanotechnology-based approach to discriminate between exhaled breath of healthy states and of ESRD states. **Source: Nanotechnology breath analyzer for kidney failure** . This work is detailed in the paper Sniffing Chronic Renal Failure in Rat Model by an Array of Random Networks of Single-Walled Carbon Nanotubes.

An unlikely multidisciplinary scientific collaboration has discovered that an electronic nose developed for air quality monitoring on Space Shuttle Endeavour can also be used to detect odour differences in normal and cancerous brain cells. The results of the pilot study open up new possibilities for neurosurgeons in the fight against brain cancer. The electronic nose, which is to be installed on the International Space Station in order to automatically monitor the station's air, can detect contaminants within a range of one to approximately 10,000 parts per million. In a series of experiments, the Brain Mapping Foundation used NASA's electronic nose to sniff brain cancer cells and cells in other organs. Their data demonstrates that the electronic nose can sense differences in odour from normal versus cancerous cells. These experiments will help pave the way for more sophisticated biochemical analysis and experimentation. Babak Kateb, Chairman and Scientific Director of the Brain Mapping Foundation, is the lead author of the paper set to be published in an IBMISPS-NeuroImage special issue in July. **Source: NASA's Electronic Nose May Provide Neurosurgeons With A New Weapon Against Brain Cancer**.

# Cheap, fast, portatil and performant, must be nanotechnology. Lung Cancer Nanobiosensor

Victor Puntes, 4 September 2009
tags: detection + nanoparticles + nanomedicine + nano-oncology + Victor Puntes

In miniaturization, mimicking the sense of smell has been a major target. The Smell is composed of thousands integrated specific receptors, in fact, the Smell occupais about a thousand of gens and such a huge analyzing library has to be schrinked to fit in a body. With nanotehcnology success is closer. Already, using carbon nanotubes these principles have been tested and verified. Now, changing the material, using gold nanoparticles.

"A highly sensitive and fast-response array of sensors based on gold nanoparticles, in combination with pattern recognition methods, can distinguish between the odor prints of non-small-cell lung cancer and negative controls with 100% accuracy, with no need for preconcentration techniques. Additionally, preliminary results indicate that the same array of sensors might serve as a better tool for understanding the biochemical source of volatile organic compounds that might occur in cancer cells and appear in the exhaled breath, as compared to traditional spectrometry techniques. The reported results provide a launching pad to initiate a bedside tool that might be able to screen for early stages of lung cancer and allow higher cure rates. In addition, such a tool might be used for the immediate diagnosis of fresh (frozen) tissues of lung cancer in operating rooms, where a dichotomic diagnosis is crucial to guide surgeons." From Sniffing the Unique Odor Print of Non-Small-Cell Lung Cancer with Gold Nanoparticles by Orna Barash, Nir Peled, Fred R. Hirsch, Hossam Haick.

"Conventional diagnostic methods for lung cancer are unsuitable for widespread screening because they are expensive and occasionally miss tumours. Gas chromatography/mass spectrometry studies have shown that several volatile organic compounds, which normally appear at levels of 1–20 ppb in healthy human breath, are elevated to levels between 10 and 100 ppb in lung cancer patients. Here we show that an array of sensors based on gold nanoparticles can rapidly distinguish the breath of lung cancer patients from the breath of healthy individuals in an atmosphere of high humidity. In combination with solid-phase microextraction, gas chromatography/mass spectrometry was used to identify 42 volatile organic compounds that represent lung cancer biomarkers. Four of these were used to train and optimize the sensors, demonstrating good agreement between patient and simulated breath samples. Our results show that sensors based on gold nanoparticles could form the basis of an inexpensive and non-invasive diagnostic tool for lung cancer." From Diagnosing lung cancer in exhaled breath using gold nanoparticles by Gang Peng, Ulrike Tisch, Orna Adams, Meggie Hakim, Nisrean Shehada, Yoav Y. Broza, Salem Billan, Roxolyana Abdah-Bortnyak, Abraham Kuten & Hossam Haick.

Related quotas.
Background: **Diagnosis through breath**

# First use of label-free nanosensors with physiological solutions

josep saldaña, 21 December 2009
tags: nanomedicine + nano-oncology + detection + nanoelectronics

A team led by Yale University researchers has **used nanosensors to measure cancer biomarkers in whole blood for the first time**. Their findings could dramatically simplify the way physicians test for biomarkers of cancer and other diseases.

The team—led by Mark Reed, Yale's Harold Hodgkinson Professor of Engineering & Applied Science, and Tarek Fahmy, an associate professor of biomedical and chemical engineering—used nanowire sensors to detect and measure concentrations of two specific biomarkers: one for prostate cancer and the other for breast cancer.

**"Nanosensors have been around for the past decade, but they only worked in controlled, laboratory settings," Reed said. "This is the first time we've been able to use them with whole blood, which is a complicated solution containing proteins and ions and other things that affect detection."**

To overcome the challenge of whole blood detection, the researchers developed a novel device that acts as a filter, catching the biomarkers—in this case, antigens specific to prostate and breast cancer—on a chip while washing away the rest of the blood. Creating a buildup of the antigens on the chip allows for detection down to extremely small concentrations, on the order of picograms per milliliter, to within an accuracy of plus or minus 10 percent. This is the equivalent of being able to detect the concentration of a single grain of salt dissolved in a large swimming pool.

Until now, detection methods have only been able to determine whether or not a certain biomarker is present in the blood at sufficiently high concentrations for the detection equipment to give reliable estimates of its presence. "This new method is much more precise in reading out concentrations, and is much less dependent on the individual operator's interpretation," Fahmy said.

In addition to relying on somewhat subjective interpretations, current tests are also labor intensive. They involve taking a blood sample, sending it to a lab, using a centrifuge to separate the different components, isolating the plasma and putting it through an hours-long chemical analysis. The whole process takes several days. In comparison, the new device is able to read out biomarker concentrations in just a few minutes.

**"Doctors could have these small, portable devices in their offices and get nearly instant readings,"** Fahmy said. **"They could also carry them into the field and test patients on site."**

The new device could also be used to test for a wide range of biomarkers at the same time, from ovarian cancer to cardiovascular disease, Reed said. "The advantage of this technology is that it takes the same effort to make a million devices as it does to make just one. We've brought the power of modern microelectronics to cancer detection." **Source:** From Scientists Use Nanosensors for First Time to Measure Cancer Biomarkers in Blood.
This work is detailed in the paper Label-free biomarker detection from whole blood by Eric Stern, Aleksandar Vacic, Nitin Rajan, Jason Criscione, Jason Park, Mark Reed and Tarek Fahmy (all of Yale University); Bojan Ilic (Cornell University); David Mooney (Harvard University).

# Nanoscopic changes to pancreatic cells reveal cancer

josep saldaña, 24 February 2009
tags: nanophotonics + detection + nanomedicine + nano-oncology + microscope

A team of researchers in Chicago has developed a way to examine cell biopsies and detect never-before-seen signs of early-stage pancreatic cancer. Though the new technique has not yet proven effective in double-blind clinical trials, it may one day help diagnose cancers of the pancreas and, potentially, other organs at their earliest and most treatable stages, before they spread.

A team from Northwestern University and NorthShore University HealthSystem describes the first application of their new technique, which they call partial wave microscopic spectroscopy. This technique allows them to examine cell samples taken from people who have undergone screening for pancreatic cancer to detect signs of the disease.

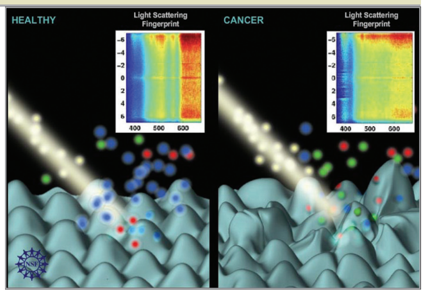
Pancreatic cancer is typically diagnosed by hospital pathologists who look for telltale changes to the morphology of pancreatic cells when they examine cell biopsies under the microscope. The problem is that in the early stages of cancer, many early-stage cancer cells appear normal. By the time the cancerous cells undergo observable changes, it may be too late in the disease progression for effective treatment.

In fact, only 7 percent of people with pancreatic cancer are diagnosed in the earliest stages of the disease, when the cancer is still confined to its primary site. More than half of all people with the disease are not diagnosed until it has already metastasized.

"In the beginning, cells look normal," says Vadim Backman, a professor of biomedical engineering at Northwestern University who developed partial wave microscopic spectroscopy with his former graduate students Yang Liu and Hariharan Subramanian and postdoctoral fellow Prabhakar Pradhan. **The new technique measures nanoscopic changes to the interior architecture of cells — changes that may signal signs of cancer even in cells that look normal under the microscope**.

To test their technique, Backman and Subramanian collaborated with gastroenterologists Hemant K. Roy and Randall Brand, who had collected tissue samples from people undergoing biopsies to detect pancreatic cancer.

**The new technique works by detecting fluctuations in the cells' refractive index (an optical property that measures how cells bend light passing through them). No other technique has ever measured this quantitatively**, says Backman. These fluctuations are influenced by nanoscopic changes to the cells' interior architecture that often occur much earlier than the changes pathologists can detect under their microscopes. The more architectural disorder there is inside the cell, the more the refractive index fluctuates. The



How light bounces off of human tissue allow to detect subtle changes potentially caused by cancerHow light bounces off of human tissue allow to detect subtle changes potentially caused by cancer. Credit: Nicolle Rager Fuller, National Science Foundation

Chicago researchers showed that by quantifying these fluctuations, partial wave spectroscopy could identify cancer cells even in cases where they had not been detected by pathologists.

**Partial wave microscopic spectroscopy may be a boon to medicine**, if it proves effective in clinical trials at detecting cancers early — especially for people with pancreatic cancer, which is one of the most deadly forms of cancer. According to the National Cancer Institute, more than 37,000 men and women in the United States were diagnosed with pancreatic cancer in 2008, and statistically 95 percent of them will succumb to the disease within five years.

**Source:** Nanoscopic changes to pancreatic cells reveal cancer. This work is detailed in the paper Partial-wave microscopic spectroscopy detects subwavelength refractive index fluctuations: an application to cancer diagnosis by Hariharan Subramanian, Prabhakar Pradhan, Yang Liu, Ilker R. Capoglu, Jeremy D. Rogers, Hemant K. Roy, Randall E. Brand, and Vadim Backman.

# Final clinical trials for Nano-Cancer® therapy

josep saldaña, 3 November 2009
tags: nanomedicine + nanoparticles

MagForce Nanotechnologies AG, the Berlin-based medical technology company majority owned by Nanostart AG, announce the successful completion of final trials demonstrating the efficacy of its Nano-Cancer® therapy in patients with recurrent glioblastoma, a frequent form of brain tumor which is highly malignant. The actual study results significantly exceeded the study objective.

According to a previous study among a large patient population, the median survival time following diagnosis of a glioblastoma recurrence and treatment with conventional therapy (surgery, chemotherapy and radiation) is 6.2 months. The primary objective for the Nano-Cancer® therapy study was to demonstrate an extension of the median survival time in the recruited patient group by three months compared to this historical control group.

In fact, the median survival time of the 59 patients participating in the final trials was 13.4 months following treatment with Nano-Cancer® therapy in conjunction with radiation. The median survival time was thus significantly greater, more than double that of the control population.

The results were even more remarkable in that Nano-Cancer® therapy was tested not on newly diagnosed patients with primary tumors but rather as a study involving patients who had already endured treatment with conventional therapies, as well as the unpleasant effects generally associated with these. Following regulatory approval of the new therapy, it is expected that it will also be available for use in treating other types of localized tumors, as these are generally responsive to the same principle of using warmth to destroy or degrade cancer cells.

MagForce founder and chief scientific officer Dr. Andreas Jordan commented, “The results demonstrate the potential of Nano-Cancer® therapy, which at the same time has minimal patient side effects. **Our vision is to establish this new technology alongside surgery, chemotherapy and radiation as an additional pillar of cancer therapy**.”

Marco Beckmann, CEO of Nanostart AG, went on to add, “We enthusiastically congratulate Dr. Jordan and his team on the superb study results. It is my belief that **we may thank nanotechnology for a historical advance in medical science**.”

In addition to its high efficacy of which has now been conclusively demonstrated, Nano-Cancer® therapy offers an additional and very significant advantage compared to the existing conventional therapy alternatives of surgical intervention, chemotherapy and radiation: Nano-Cancer® therapy is tolerated extremely well by patients and, despite its high efficacy, has no serious or unpleasant side effects.

The results of these clinical trials will now form the basis of application for EU regulatory approval for the new therapy, which will be submitted before the end of this year. Once EU regulatory approval has been obtained,MagForce will be able to market its Nano-Cancer® therapy throughout the European Union. The detailed study results will be published shortly in a medical journal.

Nano-Cancer® therapy represents a completely new way to fight cancer and is world’s first approach to use magnetic nanoparticles to treat tumors with virtually no side effects. This is done by injecting specially coated iron oxide nanoparticles directly and precisely into the tumor so that they remain concentrated in the tumor and do not diffuse into the surrounding healthy tissue. The nanoparticles within the tumor are then heated to an exact temperature by externally applying an external magnetic field. In this way, tumor temperatures of up to 70°C (158°F) can be precisely attained within a fraction of a degree. This heat damages the tumor or destroys it completely. During the treatment procedure, patients feel only a moderate warming sensation.

**Source:** Nanostart majority-owned MagForce announces successful completion of final clinical trials for Nano-Cancer® therapy.

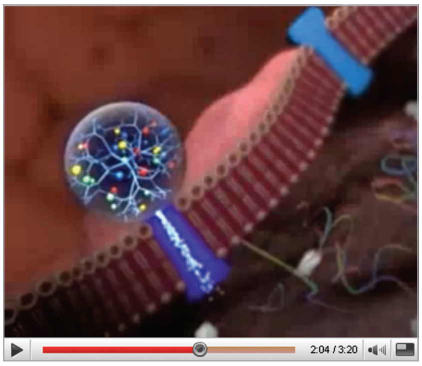
# Video Journey Into Nanotechnology

josep saldaña, 23 April 2009
tags: educational + nano-oncology + video

In the fight against cancer, nanotechnology introduces **unique approaches to diagnosis and treatment** that could not even be imagined with conventional technology.

New tools engineered at sizes much smaller than a human cell will enable researchers and clinicians to detect cancer earlier, treat it with much greater precision and fewer side effects, and possibly stop the disease long before it can do any damage. [See nano-oncology]

Imagine a nanoparticle that can be used to light up a tumor in an MRI, destroy cancer cells by converting magnetic fields into heat, and allow the physician to visually track the progress of treatment. To learn more about the possibilities of nanotechnology in cancer and explore the field, a **Video Journey Into Nanotechnology**. The National Cancer Institute (NCI), part of the National Institutes of Health, is engaged in efforts to harness the power of nanotechnology to radically change the way we diagnose, treat and prevent cancer. The NCI Alliance for Nanotechnology in Cancer is a comprehensive, systematized initiative encompassing the public and private sectors, designed to accelerate the application of the best capabilities of nanotechnology to cancer.



Video Journey Into Nanotechnology

# From Chemistry to Biology: Nanotechnology

Victor Puntes, 9 September 2009
tags: nanoparticles + nanobiotechnology + nanomedicine + nanoimmunology + Victor Puntes

If we look at the atomic composition of a life form in earth, it is rather poor, C,H,O,N and few more at very low concentrations. Irrelevant market price. If we look at it from the chemical point of view, the vista is not improving radically: from the geranium to the elephant every thing is built up with 20 building blocks which have two chemical functions (amino group and carboxylic acid) and some of the 20 are not very abundant. However, from the biological point of view, the richness of life forms is vast. Thus, they can fly, emit light, glow discharges and be latent for hundreds of years before blossom again. In addition, life can reproduce and evolve and compute much more than today's computers. How does it go from chemistry to biology? At which moment the redundant and flat chemical composition of life forms is transformed into amazing structures? At the nanometer level. Is the molecular organization at the nanometric scale what confers biological entity to chemical compounds. /Ist est/, life emerges at the nanolevel.

Following these ideas, two papers recently showed how short peptides which had no biological relevance become strongly immunogenic when they were arranged on top of a gold nanoparticle. And the degree of immune activation dependend on the topological order of the peptide array, the more ordered the more bio-active, while the random peptidic coating of a gold nanoparticle does not elicit any biological response.

Murine bone marrow macrophages were able to recognize gold nanoparticle peptide conjugates, while peptides or nanoparticles alone were not recognized. Consequently, in the presence of conjugates, macrophage proliferation was stopped and pro-inflammatory cytokines such asTNF-a, IL-1b and IL-6, as well as nitric oxide synthase (NOS2 ) were induced. Furthermore, macrophage activation by gold nanoparticles conjugated to different peptides appeared to be rather independent of peptide length and polarity, but strongly dependent on peptide pattern at the nanoparticle surface. Correspondingly, the biochemical type of response also depended on the type of conjugated peptide and could be correlated with the degree of ordering in the peptide coating. These findings help to illustrate the basic requirements involved in medical nanoparticle conjugate design to either activate the immune system or hide from it in order to reach their targets before being removed by phagocytes, which must distinguish between self and non-self molecules to protect the host from succumbing to infections.

Related papers: Homogeneous Conjugation of Peptides onto Gold Nanoparticles Enhances Macrophage Response by Neus G. Bastús, Ester Sánchez-Tilló, Silvia Pujals, Consol Farrera, Carmen López, Ernest Giralt, Antonio Celada, Jorge Lloberas and Victor Puntes. Peptides conjugated to gold nanoparticles induce macrophage activation by Bastús NG, Sánchez-Tilló E, Pujals S, Farrera C, Kogan MJ, Giralt E, Celada A, Lloberas J, Puntes V.

# Influenza detection systems, vaccine and nanoviricide anti-influenza drug

josep saldaña, 29 April 2009
tags: nanomedicine + detection + nanoimmunology

Envision ALR, an emerging technology investment & operating company announced that it is commercialising a new form of nanotechnology based infectious disease detection system with the capability to distinguish between different flu strains within seconds. The technology has already been shown to be effective in lab tests and the company is now accelerating the commercialisation program."With current disease identification technologies requiring blood samples to be shipped to a laboratory for testing, distinguishing between pandemic strains and common ones can take up to twenty-four hours. Our technology has the potential to reduce this to under a minute, requires either a pin prick of blood or a salvia sample and will deliver the result of the diagnoses on the spot." The technology is based on printed electronics, making use of the unique properties of a number of nanoparticle based inks and is rapid, accurate, and the hand held device is easily portable for use in doctors surgeries, hospitals or airports. The system works for both bacterial and viral pathogens. **Source:** Envision ALR Announces Rapid Screening For Swine Flu And Other Pathogens Using Novel Nanotechnology Based Plastic Electronics.

CombiMatrix's Influenza-Detection System provides very-high-resolution genotype information on any given flu strain, as well as information on novel strains of flu produced by rapid mutation or recombination between multiple strains. The current **Swine Flu** is a novel strain of influenza A, subtype H1N1. Other strains of influenza A include pathogenic Bird Flu (H5N1); the 1918 influenza pandemic (H1N1), which killed an estimated 50 million people; the 1968 Hong Kong Flu (H3N2), which caused a pandemic; and the 1976 Swine Flu (H1N1). CombiMatrix's Influenza Microarray can detect and distinguish each of these strains, as well as all other circulating subtypes and strains of Influenza A. Most importantly, as demonstrated by news, the array can be updated almost instantaneously. **Source:** CombiMatrix Updates its Influenza-Detection Microarray to Include Swine Flu.

Liquidia Technologies presented data at the **National Foundation of Infectious Disease (NFID)** which supports new insight into a technology that could provide more safe and effective vaccines for a wide variety of diseases. Results of the study show that the desired immune response elicited by a vaccine can be enhanced up to 10-fold when the vaccine protein is linked to nano-particles of a particular size and shape. Particles mimicking the size and shape of pathogens may improve the safety and efficacy of vaccines. The discovery may lead to a new generation of vaccines that could provide faster immunity to disease and potentially minimize the need for multiple vaccinations or "booster shots." **Source:** Novel technology may pave way for next generation vaccines.

NanoViricides announced that it is developing FluCide, its flagship anti-influenza drug candidate, to work against all influenza types and subtypes. FluCide has been shown to be effective against both common influenza subtype H1N1, as well as two different variants of bird flu subtype H5N1. The Company has previously announced excellent results in both animal studies and cell culture studies against widely different influenza subtypes and strains. If these results are confirmed in further animal and human studies, thenFluCide would likely be considered the best ever drug effective against all influenzas. The Company is communicating its capabilities to various agencies involved in the current epidemic response. The current swine flu **outbreak** is significant in that the H1N1 virus causing it is novel. The pig is known to be a transitional species for influenza viruses. That means re-assortment (i.e. mixing) of genes from bird flu, human flu, and swine flu viruses can take place in pigs. This can lead to more lethal, drug resistant novel strains to emerge from different existing ones. **Source:** NanoViricides Developing FluCide to Work Against All Influenza Types and Subtypes.

# Interactions between nanomaterials, biological systems

josep saldaña, 3 July 2009
tags: nanobiotechnology + nanomaterial + nanomedicine + concerns

The recent explosion in the development of nanomaterials with enhanced performance characteristics for use in commercial and medical applications has increased the likelihood of people coming into direct contact with these materials.

There are currently more than 800 products on the market — including clothes, skin lotions and cleaning products — claiming to have at least one nanocomponent, and therapeutic nanocarriers have been designed for targeted drug delivery inside the human body. Human exposure to nanomaterials, which are smaller than one one-thousandth the diameter of a human hair, raises some important questions, including whether these "nano-bio" interactions could have adverse health effects.

Now, researchers at UCLA and the California NanoSystems Institute (CNSI), along with colleagues in academia and industry, have taken a proactive role in examining the current understanding of the nano-bio interface to identify the potential risks of engineered nanomaterials and to explore design methods that will lead to safer and more effective nanoparticles for use in a variety of treatments and products.

In a research review, the team provides **a comprehensive overview of current knowledge on the physical and chemical properties of nanomaterials that allow them to undergo interactions with biological molecules and bioprocesses**. "What we have established here is a blueprint that will serve to educate the first generation of nanobiologists," said Dr. Andre Nel, leader of the team and chief of the division of nanomedicine at the David Geffen School of Medicine at UCLA and the CaliforniaNanoSystems Institute. "Instead of waiting for knowledge to unfold randomly, we can already begin to view the events at nano-bio interface as a discoverable scientific platform that can be used for setting up a deliberate inorganic-organic roadmap to new, better and safer products," Nel said. "What we can identify by understanding the rules that shape the nano-bio interface will have a massive impact on the ability to develop safe nanomaterials in the future."

**Source:** From Research explores interactions between nanomaterials, biological systems. Review article calls for measures to enable safe design of nanomaterials By Jennifer Marcus. This work is detailed in the paper Understanding biophysicochemical interactions at the nano–bio interface by Andre E. Nel, Lutz Mädler, Darrell Velegol, Tian Xia, Eric M. V. Hoek, Ponisseril Somasundaran, Fred Klaessig, Vince Castranova & Mike Thompson.

# Nano-magnets guide stem cells to damaged tissue

josep saldaña, 3 September 2009
tags: nanomedicine + video

Microscopic magnetic particles have been used to bring stem cells to sites of cardiovascular injury in a new method designed to increase the capacity of cells to repair damaged tissue. Although magnetic fields have been used to guide cellular therapies, **this is the first time cells have been targeted using a method directly applicable to clinical practice**. The technique uses an FDA (US Food and Drug Administration) approved agent that is already used to monitor cells in humans using MRI (magnetic resonance imaging).

Dr Mark Lythgoe, UCL Centre for Advanced Biomedical Imaging, the senior author of the study, said: "Because the material we used in this method is already FDA approved we could see this technology being applied in human clinical trials within three to five years. It's feasible that heart attacks and other vascular injuries could eventually be treated using regular injections of magnetised stem cells. The technology could be adapted to localise cells in other organs and provide a useful tool for the systemic injection of all manner of cell therapies. And it's not just limited to cells – by focusing tagged antibodies or viruses using this method, cancerous tumours could be much more specifically targeted."

Panagiotis Kyrtatos, also from the UCL Centre for Advanced Biomedical Imaging and lead researcher of the study, added: "This research tackles one of the most critical challenges in the biomedical sciences today: ensuring the effective delivery and retention of cellular therapies to specific targets within the body. Cell therapies could greatly benefit from nano-magnetic techniques which concentrate cells where they are needed most. The nano-magnets not only assist with the targeting, but with the aid of MRI also allow us to observe how the cells behave once they're injected."

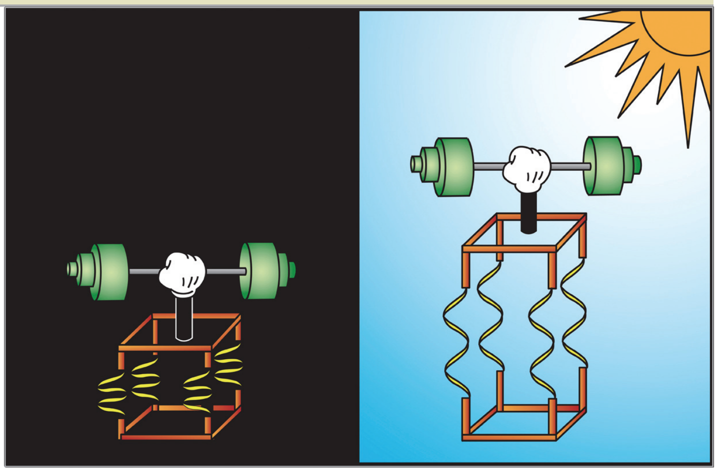
John Martin, Professor of Cardiovascular Medicine at UCL, is another of the paper's co-authors. He commented: "UCL is already leading clinical trials in stem cells in repairing the damaged heart. This paper describes how a second generation of improved cells might be targeted to damaged areas. Research such as this directly informs the future design of clinical trials. It is a great reminder that clinical research must be informed by basic research and that results from scientific laboratories can be highly relevant to clinical medicine, and to patients."

**Source:** From Nano-magnets guide stem cells to damaged tissue. This work is detailed in the paper Magnetic Tagging Increases Delivery of Circulating Progenitors in Vascular Injury by Panagiotis G. Kyrtatos, Pauliina Lehtolainen, Manfred Junemann-Ramirez, Ana Garcia-Prieto, Anthony N. Price, John F. Martin, David G. Gadian, Quentin A. Pankhurst, Mark F. Lythgoe.

see the video Nano magnets guide stem cells to damaged tissue (video)

# Light-driven nanomotor built with a single molecule of DNA

josep saldaña, 10 June 2009
tags: nanomachinery + nanodevice + nanobiotechnology + nanophotonics



Sunlight prompts a newly developed molecular nanomotor to unclasp Sunlight prompts a newly developed molecular nanomotor to unclasp in this artist's illustration. In its clasped, or closed, form, the nanomotor measures 2 to 5 nanometers — 2 to 5 billionths of a meter. In its unclasped form, it extends as long as 10 to 12 nanometers. Yan Chen/University of Florida

A team of chemists is the latest to report **a new mechanism to transform light straight into motion**. In a paper, the University of Florida team reports building a new type of "molecular nanomotor" driven only by photons, or particles of light. While it is not the first photon-driven nanomotor, the almost infinitesimal device is the **first built entirely with a single molecule of DNA** — giving it a simplicity that increases its potential for development, manufacture and real-world applications in areas ranging from medicine to manufacturing, the scientists say.

In coming years, the nanomotor could become a component of microscopic devices that repair individual cells or fight viruses or bacteria. Although in the conceptual stage, those devices, like much larger ones, will require a power source to function. Because it is made of DNA, the nanomotor is biocompatible. Unlike traditional energy systems, the nanomotor also produces no waste when it converts light energy into motion.

"The major difficulty lies ahead," said Weihong Tan, a UF professor of chemistry and physiology, author of the paper and the leader of the research group reporting the findings. "That is how to collect the molecular level force into a coherent accumulated force that can do real work when the motor absorbs sunlight." Tan added that the group has already begun working on the problem. "Some prototype DNA nanostructures incorporating single photo-switchable motors are in the making which will synchronize molecular motions to accumulate forces," he said.

To make the nanomotor, the researchers combined a DNA molecule they created in the lab with azobenzene, a chemical compound that responds to light. A high-energy photon prompts one response; lower energy another. To demonstrate the movement, the researchers attached a fluorophore, or light-emitter, to one end of the nanomotor and a quencher, which can quench the emitting light, to the other end. Their instruments recorded emitted light intensity that corresponded to the motor movement.

"Radiation does cause things to move from the spinning of radiometer wheels to the turning of sunflowers and other plants toward the sun," said Richard Zare, distinguished professor and chairman of chemistry at Stanford University. "What Professor Tan and co-workers have done is to create a clever light-actuated nanomotor involving a single DNA molecule. I believe it is the first of its type."

**Source:** New, light-driven nanomotor is simpler, more promising, scientists say by Aaron Hoover, University of Florida News. This work is detailed in the paper Single-DNA Molecule Nanomotor Regulated by Photons by Huaizhi Kang, Haipeng Liu, Joseph A. Phillips, Zehui Cao, Youngmi Kim, Yan Chen, Zunyi Yang, Jianwei Li and Weihong Tan. More information: Photon-fueled single-molecule DNA nanomotor by Michael Berger, Nanowerk.

# Nanotech-enabled Consumer Products Top the 1,000 Mark

josep saldaña, 7 September 2009
tags: dissemination + public opinion

**Nanotech consumer products have now crossed the millennial threshold**. Over 1,000 nanotechnology-enabled products have been made available to consumers around the world, according to the Project on Emerging Nanotechnologies (PEN). The most recent update to the group's three-and-a-half-year-old inventory reflects the increasing use of the tiny particles in everything from conventional products like non-stick cookware and lighter, stronger tennis racquets, to more unique items such as wearable sensors that monitor posture.

"The use of nanotechnology in consumer products continues to grow rapidly," says PEN Director David Rejeski. "When we launched the inventory in March 2006 we only had 212 products. If the introduction of new products continues at the present rate, the number of products listed in the inventory will reach close to 1,600 within the next two years. This will provide significant oversight challenges for agencies like the Food and Drug Administration and Consumer Product Safety Commission, which often lack any mechanisms to identify nanotech products before they enter the marketplace."

Health and fitness items continue to dominate the PEN inventory, representing 60 percent of products listed. More products are based on nanoscale silver—used for its antimicrobial properties—than any other nanomaterial; 259 products (26 percent of the inventory) use silver nanoparticles. The updated inventory represents products from over 24 countries, including the US, China, Canada, and Germany. This update also identifies products that were previously available, but for which there is no current information.

The release of the updated inventory coincides with **the first public hearing on nanotechnology being held by the Consumer Product Safety Commission (CPSC)**. The CPSC, with a staff of fewer than 400 employees, oversees the safety of 15,000 types of consumer products.

Andrew Maynard, chief science advisor for PEN, noted that "the CPSC deserves credit for focusing on nanotechnologies. The resources available to the agency to address health and safety issues are negligible compared to the over $1.5 billion federal investment in nanotechnology research and development."

The inventory is available at http://www.nanotechproject.org/inventories/consumer/

The PEN consumer products inventory includes products that have been identified by their manufacturer or a credible source as being nanotechnology-based. This update identifies products that were previously sold, but which may no longer be available. It remains the most comprehensive and widely used source of information on nanotechnology-enabled consumer products in the world. **Source:** Nanotech-enabled Consumer Products Top the 1,000 Mark

# Debating Nanotechnology's Responsible Development

josep saldaña, 5 October 2009
tags: public opinion + concerns


Deepening Dialogue:
Debating Nanotechnology's Responsible Development

A new report by a group of leading European academics, argues that **decision-making on science - especially emerging technologies such as nanotechnology - must become more democratic**.

The report, "Reconfiguring Responsibility", was the result of a three-year research project funded by the European Commission as part of the DEEPEN (Deepening Ethical Engagement and Participation in Emerging Nanotechnologies) project. The authors strongly suggest that current governance activities are limiting public debate and may result in a repeat of the mistakes made in managing genetically modified foods.

Phil Macnaghten, a Professor at Durham University, UK, and the Project Leader, argues while talk of 'responsible development' is a step in the right direction, it often hides outdated assumptions: "**Technologies are being driven forward with insufficient reflection on why they are being developed and on what this is likely to mean for future society**. The public is keen to be involved in deliberating the often far-reaching questions that science is addressing, and policy-makers need to find new ways to ensure that public views are heard, treated with respect and used to inform science policy."

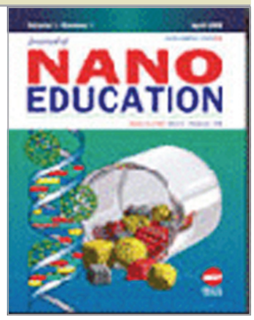
Professor Richard Jones FRS, a leading nanoscientist who until recently was the Senior Advisor for Nanotechnology for the UK government's science funding agency, agrees:

"I believe that **involving the public in decision making on science can lead to better outcomes – as well as being fascinating and rewarding for the scientists involved**. If we are to continue to make nanotechnology a more socially responsible science we need to build on research such as that discussed in the 'Reconfiguring Responsibility' report."

According to the report, the need for action on nanotechnology is even more pressing due to the fact that it has the potential to fundamentally change everyday life and thus raises profound social and ethical questions. Attention has recently focussed on the uncertainties surrounding its long-term effects on human health and the environment, but the 'Reconfiguring Responsibility' study indicates that public concern also focuses on the kind of society being created by such technologies.

# Journal of Nano Education

josep saldaña, 20 February 2009 (created 20 February 2009)
tags: educational + dissemination + public opinion



Journal of Nano Education

The first issue of the peer-reviewed international Journal of Nano Education (March 2009) now is available, published by the American Scientific Publishers. Articles appearing in the first issue will be freely available until December 31, 2009. "What makes JNE unique among the many other established journals that focus on teaching and learning in the various scientific, technological, engineering and medical disciplines? A primary area of differentiation is based on the fact that research in nanoscale science, technology, engineering and medicine inherently is an interdisciplinary endeavor (...) In particular, an overarching goal of JNE is to become a recognized leader in the development of a coherent, integrated knowledge base in **nanoscale science, technology, engineering and medical education** (...) As Roco (2003) has persuasively argued, “one of the ‘grand challenges’ for nanotechnology is education, which is looming as a bottleneck for the development of the field, and particularly for its implementation”." From "Welcome to the Journal of Nano Education" by Editor-in-Chief, Aldrin E. Sweeney.

"As the Education and Outreach Coordinator for the U.S. National Nanotechnology Infrastructure Network (NNIN), I am often asked **why there is a need for “nano-education.”** Questions arise asking if nanoscale science and engineering is truly a separate field of study; are we creating another layer in our educational system, or can nanotechnology be infused into our current science, technology, engineering, and mathematics educational system? These questions become particularly important when put in the context of the U.S. K–12 educational system, which already has content standards that must be addressed at each grade level (...) Nanotechnology is really not a new and separate field, but involves the basic building blocks of our world -atoms and molecules. Nanoscale science and engineering are rooted in the core concepts of science. What is new is that we are now increasing our understanding concerning the interaction of atoms and molecules and have the tools to manipulate them to create new materials and devices. Teachers do not need to add anything new to what they are teaching, but rather they can introduce nanotechnology into concepts they are already teaching (...) With this new-found knowledge comes an **imperative to change the way we teach science**. Nanoscale science and engineering crosses all disciplines and is truly an interdisciplinary field. This requires that we teach K–12 science not as compartmentalized subjects, but as concepts that have connection with each other. We must teach our students to be able to make connections between the sciences, which in turn requires that we teach our teacher candidates to make these same connections. Teachers also need exposure to inquiry methods, critical thinking, and problem solving and how to incorporate these into their teaching strategies. These are skills that will be needed by the nano workforce and must be part of our K–12 science curriculum (...) Nanoscale science and engineering can serve as a catalyst to excite students about science, technology, engineering, and mathematics (STEM) and, in turn, direct them to education and careers in STEM. However, to do this will **require that we continue to enhance our efforts to communicate the importance of nanoscale science and engineering to all members of our society**." **Source:** "Why Nano Education?" by Nancy Healy.

**nano**wiki**.info**

>>> tracking nanotechnology

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**Exposure to nanoparticles is related to pleural effusion, pulmonary fibrosis and granuloma**
by Yuguo Song[1], X. Li[2] and X. Du[1].

1 Dept of Occupational Medicine and Clinical Toxicology, Beijing Chaoyang Hospital, Capital University of Medical Sciences, Beijing, China
2 Dept of Pathology, Beijing Chaoyang Hospital, Capital University of Medical Sciences, Beijing, China

**The Impact of Toxicity Testing Costs on Nanomaterial Regulation**
by Jae-Young Choi[1], Gurumurthy Ramachandran[2] and Milind Kandlikar[3].

1 Division of Health Policy and Management, School of Public Health, University of Minnesota.
2 Division of Environmental Health Science, School of Public Health, University of Minnesota.
3 University of British Columbia.

**Nanotechnology and In situ Remediation: A review of the benefits and potential risks**
by Barbara Karn[1], Todd Kuiken[2], Martha Otto[1]. This article has been reviewed by the U.S. Environmental Protection Agency and approved for publication.

1 U.S. Environmental Protection Agency, Washington, D.C.
2 Woodrow Wilson International Center for Scholars, Project on Emerging Nanotechnologies, Washington, D.C.

**GoodNanoGuide shares best practices**
by International Council on Nanotechnology. Rice University

**Detection of nonpolar molecules by means of carrier scattering in random networks of carbon nanotubes: Toward diagnosis of diseases via breath samples**
by Gang Peng, Ulrike Tisch and Hossam Haick.

The Department of Chemical Engineering and Russell Barrie Nanotechnology Institute,
Technion Israel Institute of Technology, Haifa 32000, Israel

**An electronic nose in the discrimination of patients with non-small cell cancer and COPD**
by Silvano Dragonieri[1,2], Jouke T. Annema[1], Robert Schoa[1], Marc P.C. van der Schee[1,4], Antonio Spanevello[3], Pierluigi Carratú[2], Onofrio Resta[2], Klaus F. Rabe[1], Peter J. Sterk[1,2]

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2 Department of Respiratory Diseases, University of Bari, Bari, Italy
3 Department of Respiratory Diseases, Fondazione Maugeri, Cassano Murge, Italy
4 Department of Respiratory Medicine, Academic Medical Centre, University of Amsterdam, Amsterdam, The Netherlands

**Sniffing Chronic Renal Failure in Rat Model by an Array of Random Networks of Single-Walled Carbon Nanotubes**
by Hossam Haick[1,2], Meggie Hakim[1], Michael Patrascu[1], Chen Levenberg[1], Nisreen Shehada[1], Farid Nakhoul[3] and Zaid Abassi[4,5]

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**Sniffing out cancer using the JPL electronic nose: A pilot study of a novel approach to detection and differentiation of brain cancer**
by Babak Kateb[1,2,4], M.A. Ryan[3], M.L. Homer[3], L.M. Lara[3], Yufang Yin[4], Kerin Higa[4] and Mike Y. Chen[4]

1 International Brain Mapping and Intraoperative Surgical Planning Society (IBMISPS.org), USA
2 Brain Mapping Foundation, 8159 Santa Monica Blvd. #200, West Hollywood, CA 90046, USA
3 Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr. Pasadena, CA 91109, USA
4 City of Hope Cancer Center, 1500 East Duarte Road Duarte, CA 91010, USA

**Sniffing the Unique Odor Print of Non-Small-Cell Lung Cancer with Gold Nanoparticles**
by Orna Barash[1], Nir Peled[2], Fred R. Hirsch[2], Hossam Haick[1].

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2 University of Colorado Cancer Center Division of Medical Oncology Aurora, CO 80045 (USA)

**Diagnosing lung cancer in exhaled breath using gold nanoparticles**
by Gang Peng[1,2], Ulrike Tisch[1,2], Orna Adams[1], Meggie Hakim[1], Nisrean Shehada[1], Yoav Y. Broza[1], Salem Billan[3], Roxolyana Abdah-Bortnyak[3], Abraham Kuten[3,4] & Hossam Haick[1,2]

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4 Bruce Rappaport Faculty of Medicine, Technion – Israel Institute of Technology, Haifa 31096, Israel

**Label-free biomarker detection from whole blood**
by Eric Stern[1], Aleksandar Vacic[2], Nitin K. Rajan[2], Jason M. Criscione[1], Jason Park[1], Bojan R. Ilic[3], David J. Mooney[4], Mark A. Reed[2,5] & Tarek M. Fahmy[1,6]

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6 Department of Chemical Engineering, School of Engineering and Applied Science, Yale University, New Haven, Connecticut 06511, USA

**Partial-wave microscopic spectroscopy detects subwavelength refractive index fluctuations: an application to cancer diagnosis**
by Hariharan Subramanian[1], Prabhakar Pradhan[1], Yang Liu[1], Ilker R. Capoglu[1], Jeremy D. Rogers[1], Hemant K. Roy[2], Randall E. Brand[2], and Vadim Backman[1],

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**Homogeneous Conjugation of Peptides onto Gold Nanoparticles Enhances Macrophage Response**
by Neus G. Bastús[1], Ester Sánchez-Tilló[2], Silvia Pujals[3], Consol Farrera[2], Carmen López[4], Ernest Giralt[3,4], Antonio Celada[2], Jorge Lloberas[2] and Victor Puntes[1,5].

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**Peptides conjugated to gold nanoparticles induce macrophage activation**
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**Understanding biophysicochemical interactions at the nano–bio interface**
by Andre E. Nel[1], Lutz Mädler[2], Darrell Velegol[3], Tian Xia[1], Eric M. V. Hoek[4], Ponisseril Somasundaran[5], Fred Klaessig[6], Vince Castranova[7] & Mike Thompson[8]

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**Magnetic Tagging Increases Delivery of Circulating Progenitors in Vascular Injury**
by Panagiotis G. Kyrtatos[1,2,4], Pauliina Lehtolainen[1], Manfred Junemann-Ramirez[3], Ana Garcia-Prieto[5], Anthony N. Price[1], John F. Martin[3], David G. Gadian[2], Quentin A. Pankhurst[4,5], Mark F. Lythgoe[1,2]

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# epilogue

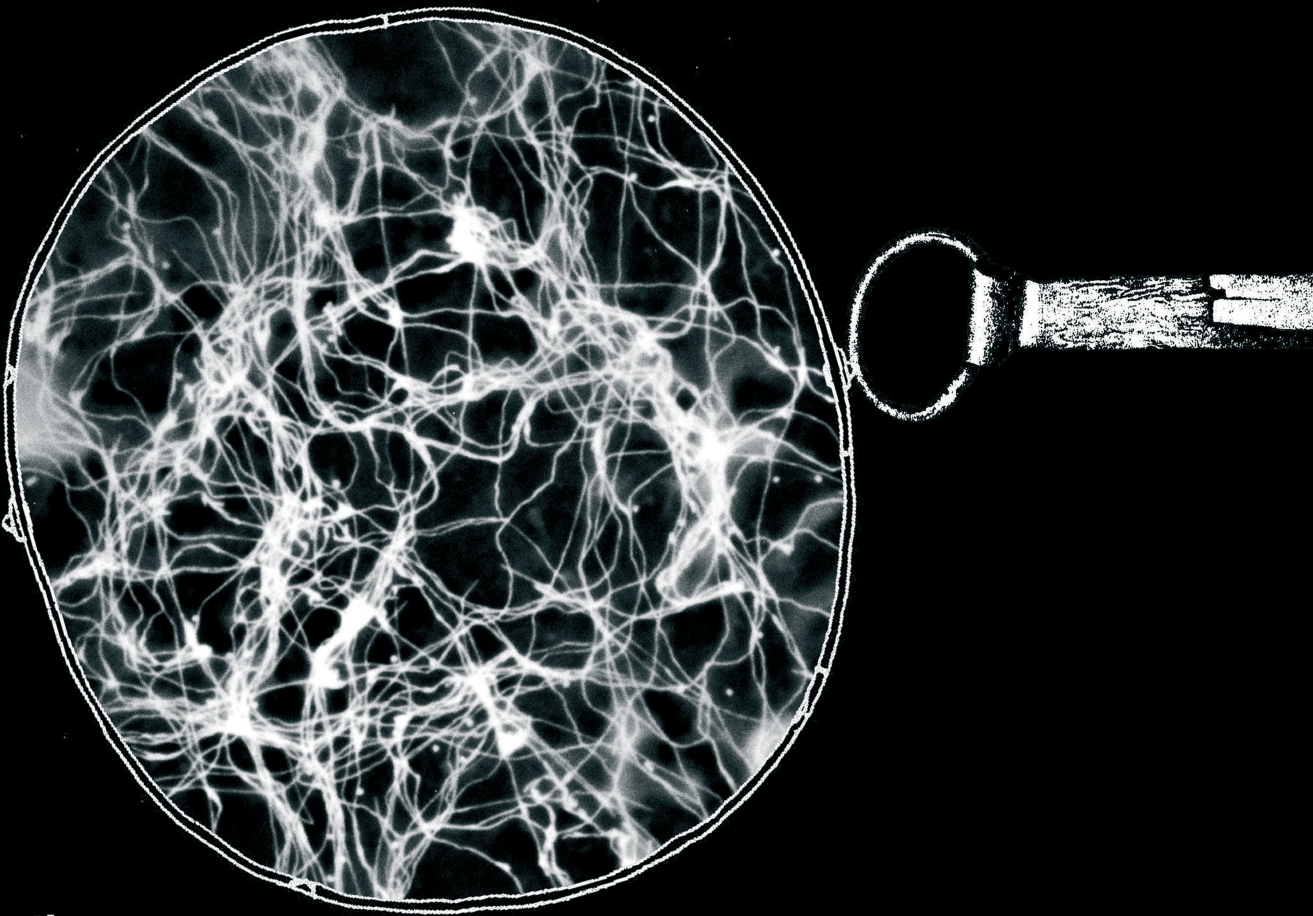
"Let's not pretend that things will change if we keep doing the same things. A crisis can be a real blessing to any person, to any nation. For all crises bring progress.

Creativity is born from anguish, just like the day is born from the dark night. It's in crisis that inventive is born, as well as discoveries, and big strategies. Who overcomes crisis, overcomes himself, without getting overcome. Who blames his failure to a crisis neglects his own talent, and is more respectful to problems than to solutions. Incompetence is the true crisis.

The greatest inconvenience of people and nations is the laziness with which they attempt to find the solutions to their problems. There's no challenge without a crisis. Without challenges, life becomes a routine, a slow agony. There's no merit without crisis. It's in the crisis where we can show the very best in us. Without a crisis, any wind becomes a tender touch. To speak about a crisis is to promote it. Not to speak about it is to exalt conformism. Let us work hard instead.

Let us stop, once and for all, the menacing crisis that represents the tragedy of not being willing to overcome it."

Albert Einstein





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